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1954

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IN THIS ISSUE:

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TREE-PLANTING IN TANGANYIKA: III—SPECIES FOR DRY AREAS

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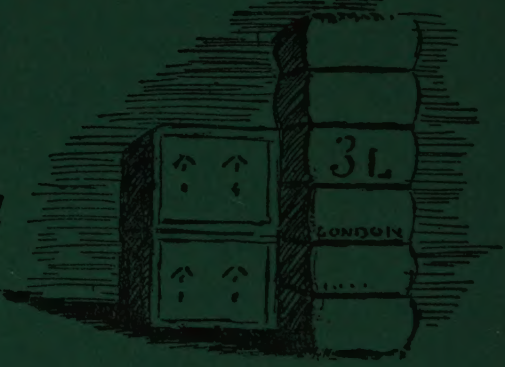

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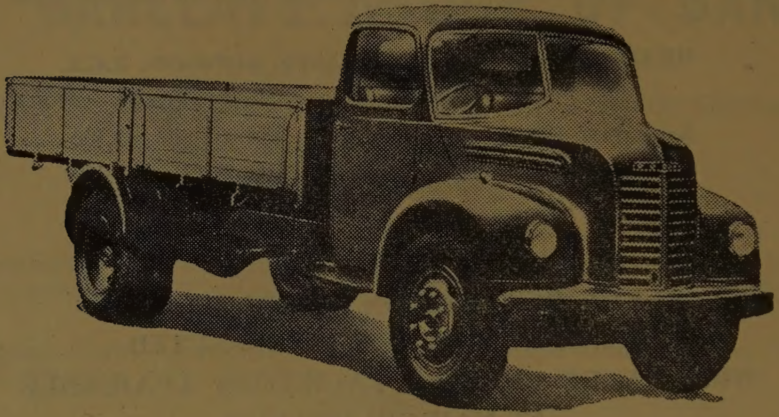

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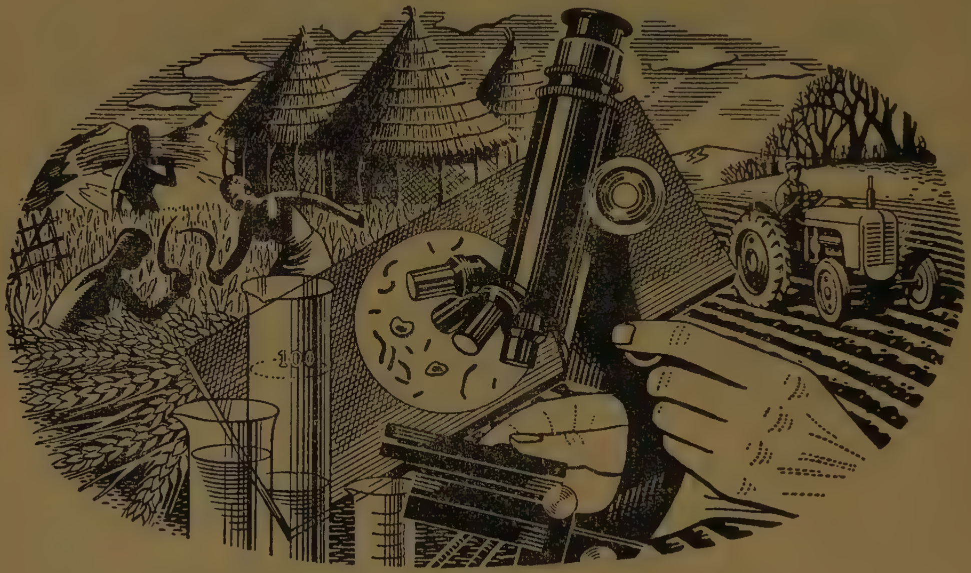

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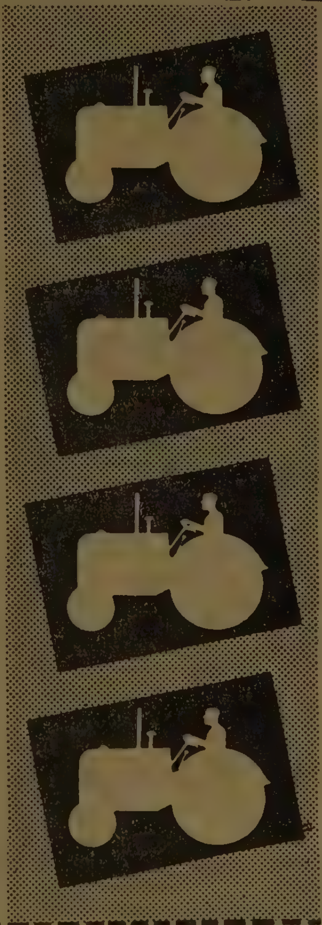

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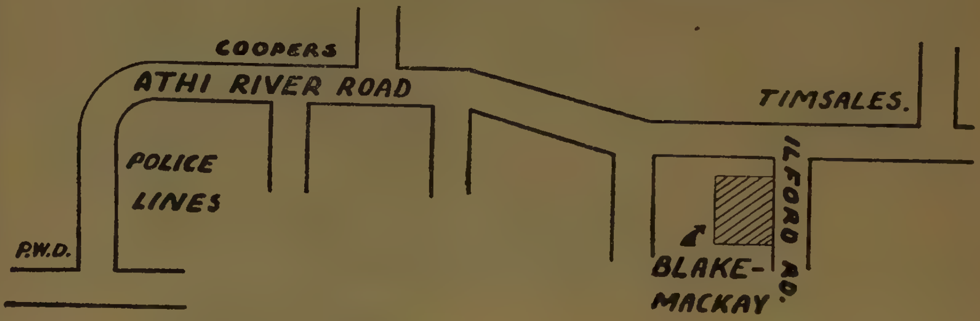

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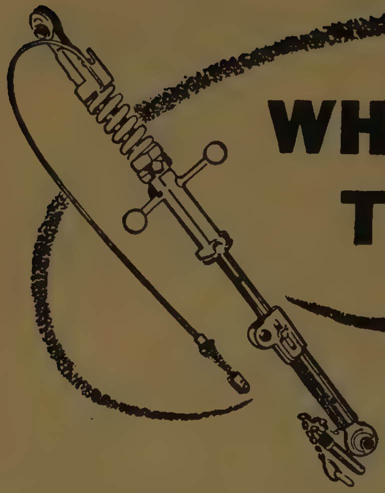
Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Director of Agriculture, and not to the Editor.

CONTENTS

PAGE
Feeding the World in the Future 127
The Quelea Threat to Africa's Grain Crops .. 133
The Reliability of Rainfall within the Growing Season 137
Letter to the Editor 139
A Practical Guide to Coco-nut Planting .. 140
The Preparation of Crocodile Skins for Export 143
Relative Values of Feeding-stuffs 150
The Chemical Composition of Three "Weeds" in the Kenya Highlands 152
Tree-planting in Tanganyika: III—Species for Dry Areas 154
Destocking and Culling in Tanganyika .. 161
Timu, and the Vanishing Forests of North-east Karamoja 164
Intensive Egg Production for the Smallholder in Uganda 168
Fertilizer Experiments on Grassland in the Kenya Highlands 171
The Development of Feeding Standards for Cattle 179
A Note on the Biology of *Calidea aregei* Germ 188
Notes on East African Aphids: V—Aphids of Citrus, Coffee and Tea 193
Soil Blocks 194
Book Reviews 196
Scientific Conference 198
The International Union of Forest Research Organizations 199

INDEX TO ADVERTISERS

PAGE
African Explosives & Chemical Industries (E.A.), Ltd. XIV
African Mercantile Co., Ltd. XI
Barclays Bank (D.C. & O.) IV
Blake-Mackay Engineering Co. (Africa), Ltd. XVI
Bovill, Matheson & Co., Ltd. IX
BP (East Africa), Ltd. XV
Caltex (Africa), Ltd. .. .. .. COVER PAGE 3
Craelius East African Drilling Co., Ltd. .. IV
Dunlop Tyres .. .. COVER PAGE 4
East African Breweries, Ltd. VII
East African Railways and Harbours .. I
Gailey & Roberts, Ltd. VIII
International Harvester Co. of E.A., Ltd. .. XII
Kinleven, Ltd. XIII
Macgregor-Oates Motors, Ltd. VI
National Bank of India, Ltd. V
Ndurumo, Ltd. X
Pest Control (E.A.), Ltd. III
R. E. Smith, McCrae, Johnson & Co., Ltd. II
Smith, Mackenzie & Co., Ltd. .. .. COVER PAGE 2
South British Insurance Co., Ltd. XIII
Standard Bank of South Africa, Ltd. .. V
Twentsche Overseas Trading Co., Ltd. .. XVIII
United Africa Company (Kenya), Ltd. .. XI



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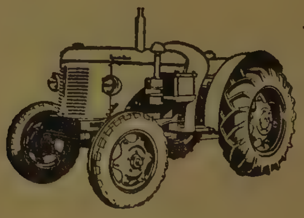

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FEEDING THE WORLD IN THE FUTURE

Early in 1953, a discussion on "Food and the Future" was held by the Food Group of the Society of Chemical Industry, London, and the eight papers* which were read at the meetings give the views of scientists who have studied the problem from widely differing angles. At the opening meeting F. Le Gros Clark surveyed the subject in relation to the rapidly increasing population of the world, and the fear that one day the human race may not be able to produce sufficient food to feed itself. That fear was the underlying reason why this symposium was held, in order to "attract as many people as possible across the gulf of pessimism to the side of a rational and tolerant optimism". Even though the world population has increased from about 540,000,000 in 1650 to 2,350,000,000 in 1950, Le Gros Clark does not think it inevitable that the present rate of increase should be continued indefinitely. He points out that the population of the British Isles almost doubled between 1801 and 1850, but the rapid rise in the standard of living was accompanied by a gradual decline in the birth-rate. This trend is reflected over Europe as a whole, since the population figures during the past 100 years are: 266,000,000 in 1850, 401,000,000 in 1900, and 580,000,000 in 1950. On the other hand, the population of Asia has risen rapidly in the last 50 years, the population figures being 749,000,000 in 1850, 937,000,000 in 1900, and 1,280,000,000 in 1950. The corresponding population figures for Africa are 95,000,000 in 1850, 120,000,000 in 1900, and 182,000,000 in 1950. Thus the peoples of Asia and Africa have reached their phase of accelerated growth, but it does not necessarily follow that this rapid increase will be maintained for an indefinite period. Le Gros Clark points out that the food producers of the world still make up close on 70 per cent of the world's inhabitants, and then goes on: "A change in the farming methods of peasants, a change in their consumer habits, a change in their breeding habits—these are but three elements of a single process of change: and the process must begin on the farms. Turn the peasant into an alert, modern farmer, and there is some prospect of getting him and his wife to think in terms of scientific family control. But the order cannot be reversed".

Taken from its context, this reasoning might suggest that the world population will ultimately right itself and that we can be complacent about the future of food supplies, but the author is merely trying to bring the alarmists and pessimists over to reasoned optimism. He appreciates that there will still be a rapid increase in the world population even if the present rates of increase in Asia and Africa are not maintained. Even in Europe there are now 180,000,000 more mouths to feed than there were in 1900, in spite of the slower rate of increase in population. In Le Gros Clark's view, the problem of feeding the world in the future is serious but not insoluble.

In the second paper of the series, E. W. Russell deals mainly with factors which limit food production, and he divides these into three groups. First there are the inherent factors of the site: lack of soil or of water, lack of plant nutrients, and too short a growing season for useful plant-growth. The second group includes those factors which harm the growing crop, such as plant diseases and pests, and finally there are the human factors—lack of skill, inherent dislike of work, debility due to disease and excessive demands of landlords. Russell continues, "Social and religious customs can also act as a brake on production. Thus, so long as a man must buy his wife for a fixed number of cattle, no matter what condition they are in so long as they are living, there is no possibility of improving the quality or productiveness of these animals. Nor if religion is held to forbid the slaughter of cattle, so that many are left to roam the common lands, can there be any possibility of improving the quality of the communal pastures. Altering these customs and taboos must in the nature of things be a very slow process, if one wants to rely on the methods of democracy rather than those of the police State".

In theory, most of these limiting factors could be corrected to some extent at least. Lack of plant nutrients can be overcome by the use of organic and inorganic fertilizers; pests and diseases may eventually be controlled by insecticides, by breeding resistant varieties, and by control of cropping; education can improve farming skill; the health of the farmer can be improved; land tenure can be controlled, and, in time, social and religious customs can be altered. Even lack of rain may be ameliorated to some extent by growing only those crops which require least water, by finding the correct proportion of forest to farm lands, by large-scale irrigation, and by meteorological and hydrological studies which provide more accurate information on the rainfall pattern of the area and on the movement of water in the surface and sub-surface layers. But much research, both scientific and sociological, is required in order to overcome these limiting factors, and it is important that a proper balance should be established between research for improving crop production in the intensively farmed temperate areas and that for making better use of the vast undeveloped tropical areas of the world.

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* These papers are published in *Chemistry and Industry*, 31st January, 14th February, 9th May, 6th June, 13th June, 1953, and in the *Journal of the Science of Food and Agriculture*, January, 1953.

In the third paper of the series, G. A. C. Herklots describes the organization of food supplies which was introduced into the Colony of Hong Kong immediately after the war, and the striking improvement in the nutritional status of the inhabitants shows that the gap between producer and consumer may vitally affect the food supply. Before the war the marketing of both fish and vegetables was in the hands of a few middlemen, who had complete control of the prices paid to the producer and by the consumer. The fisherman had to dispose quickly of his perishable catch, and it was most convenient to do this through a middleman, who collected and marketed his fish for him and paid him a proportion of its value. When hard times came he borrowed money from the middleman in order to buy gear and pay his crew, and he rarely managed to redeem his loan. As a result, he merely eked out an existence and could not improve his method of fishing or his standard of living. The vegetable grower, with his small plot of land, was dependent on outside transport to carry his produce to market, and he became deeply involved with middlemen who collected his vegetables and paid him low prices. Thus neither fishermen nor farmers had any incentive to produce more food, since it was to the middlemen's interest to keep supplies down and prices up.

During 43 months of internment by the Japanese, Herklots and his colleagues from the Hong Kong Government had time to ponder over the situation and to work out schemes by which the supply of food could be improved in the Colony; they put their own bitter experiences of malnutrition to good purpose. Within a week of the re-occupation of the Colony by the British a detailed marketing scheme for fish was accepted by the military administration, and within seven weeks a staff of 147 had been recruited and trained. Over 2,000 fishing vessels and 26,000 men, women and children had been registered two months after re-occupation, and the numbers have now risen to 5,000 vessels and 60,000 fisherfolk. All fish landed in the Colony are sold by public auction at a single wholesale fish market, 6 per cent commission being deducted for overheads; co-operative district syndicates have been set up in each of the main fishing villages; savings and loan accounts have been instituted; and now the organization has started vernacular schools and social amenities. At present the annual sales of fish are in the region of 30,000 tons with a wholesale value between £2,250,000 and £2,500,000 sterling.

A similar organization for the marketing of vegetables was started one year after the end of the war, and it now handles about 5,000 tons a month, with a permanent staff of 290 and lorry transport covering 3,000 miles a day. To-day, even though nearly 1,000,000 of the 2,500,000 inhabitants are refugees, there is little evidence of malnutrition, thanks to the plentiful supply of inexpensive fresh food in a really fresh condition.

In his paper, John Yudkin discusses food production in Israel, since the methods of agricultural development in that country demonstrate lines on which other similar areas may be developed in the future. In Biblical times the northern part of the Negev desert was a most fertile area, and archæological studies have revealed towns and villages, with systems of irrigation and signs of contour cultivation. Yudkin says, "The changing fortunes of Palestine led eventually to a population of nomadic tribes; trees were cut down, shrubs and pastures destroyed by herds of goats and another desert was created. It has been well said that the nomad is not so much the son of the desert as its father". Proposals have been drawn up for the irrigation of this area and of much of the remainder of Israel, and, although those large-scale projects are not likely to be completed for many years, they provide a basis on which smaller schemes are being carried out. In brief, the overall plan is to divert the Jordan and perhaps one or two other rivers in the north, down the length of the country into the Negev, by-passing the Dead Sea. Associated with this would be a canal from the Mediterranean into the Dead Sea; this would flow at a rate that would match the evaporation of the Dead Sea, and the fall of 1,300 ft. would provide a considerable source of hydro-electric power. If in addition another canal was constructed from the southern end of the Dead Sea to the Gulf of Akaba, which leads into the Red Sea, there would be an alternative to the Suez Canal. In case these may appear to be mere Zionist dreams, it must be pointed out that Israel covers under 8,000 square miles, about the size of Wales.

The expansion of agriculture in Israel since it became an independent State in 1949, though insignificant in relation to the future of world food production as a whole, is impressive in itself, and much can be learned from that country when plans are considered for other under-developed areas.

The efficient use of sunlight for food production is discussed by N. W. Pirie, his theme being that "our income of sunlight is the present source of our food supplies". The first part of the paper deals with the green plant as a means of trapping the sun's energy, and an interesting comparison is made between the uses of water for irrigation and for hydro-electric power. It is obvious that the most effective means of using a river is to generate electricity in its upper waters and then to use its lower reaches for irrigation, but this is not always possible. As a theoretical example, Pirie chooses a case where farmland and water are at the top of a cliff while there is only room for a power station at the foot, so that any water used for irrigation will diminish the power output. He calculates that 100 tons of water falling 100 metres will produce energy equivalent to that produced when 8 kilos of crop are burned efficiently, and allowing for only 20 per cent efficiency for furnace and generator, he finds that 40 kilos of dry crop could be burned to produce as much electricity as 1 in. of rain or irrigation water spread over an acre.

The problem then becomes that of finding whether 1 in. of irrigation water per acre will give an increase of more than 40 kilos of dry crop, and Pirie quotes results of field experiments which indicate that grass could give nine times, lucerne five times and potatoes twelve times this increase in yield. Thus, where water cannot be used first for generating electricity and afterwards for irrigation crops, it would be more efficient (though not necessarily cheaper) to use the water for irrigation and to burn a proportion of the crop for generating electricity. While this theoretical reasoning has limited practical applications, it does suggest that "synthetic" food is likely to be much less efficiently produced than that grown under natural conditions.

Since the green plant is the most efficient converter of the sun's energy, there is reason to search for the most efficient of the green plants, and studies have been made of *Chlorella*, one of the green algæ, which is said to be a possible source of food. Yields as high as 30–60 tons of dry matter per acre per annum have been claimed, but these figures are obtained by multiplying the yield of small laboratory experiments, and cannot be looked on as an indication of what could be obtained on a commercial scale. *Chlorella* is grown in a nutrient solution in shallow, warmed tanks, through which is pumped purified carbon dioxide, and at present the cost of production is entirely uneconomic. Yet research on this may possibly lead to improvements in technique or even to entirely new ideas, and it would be unwise to abandon the work on the grounds that we cannot see how it could be applied to the economics of crop production.

Pirie and his colleagues have been working on a method of food production which is interesting in theory and may eventually be important in practice. Since it seems certain that for many years to come the green plant will be our main source of food, the leaf of the plant, where the food components are synthesized naturally, is worthy of a study as a source of food. Pirie puts the problem as follows: "Leaves are widely eaten in small quantities as flavouring materials; their consumption in bulk has generally only been advocated by people with a political motive or with uncertain mental stability. Young, vigorously-growing leaves, however, often contain 30 to 40 per cent of protein and little fibre. If suitably selected they would be valuable food for people and research should be directed towards establishing the conditions under which leaves of this very high quality could be produced regularly. They could be used as food either directly or after sufficient treatment to remove unattractive flavours. But only a few plant species will stand up to continuous cropping of very young leaves and even if they survive they have their growth seriously impaired. It is not, therefore, likely that crop varieties and techniques of husbandry will be developed that will enable all of a highly productive crop to be harvested as leaves with such a high protein content that they could be eaten directly in bulk. The lower quality leaves could be fed to animals, but it would be more efficient to try to process them so that they could be used also as human food. Their defect is that as the protein content falls the fibre content in general goes up and it is this that makes the leaf unsuitable for use as food by non-ruminants. The solution lies in separating proteins and digestible fats and carbohydrates from the fibre by mechanical or chemical means".

Although laboratory methods of separating proteins from leaves have been used for many years, commercial methods have not been very successful, mainly because the equipment was not suitable. Pirie and his colleagues have now designed a mill which will grind 6 tons of very succulent leaves in an hour with the expenditure of 20 h.p., but there still remains the problem of designing a machine which will effectively press the juice out from the ground mass. There is little doubt that the latter difficulty will be overcome, and it seems certain that the extraction of food from leaves is a workable proposition; in fact extraction from grass of protein concentrates for cattle is now being carried out in a pilot plant in England.

The expressed juice is heated to give a coagulum and a residual fluid, and the leaves have then been separated into three fractions: the fibrous residue, which contains cellulose, hemicelluloses, lignins and pectin, and could be used as a food for ruminants; the fluid residue, which contains sugars, amides, amino-acids and salts, and could be used in making up mashes for poultry and pigs or for the culture of micro-organisms such as yeast; and the coagulum, which contains proteins, fats and starch. This latter fraction would be unpalatable to human beings in its original form, but it could be dried and flavoured to taste. The present estimate of cost of production is 1s. 6d. per lb., provided that a suitable crop was grown specially for the purpose.

It is interesting to reflect that in the tropics and sub-tropics, where there is most sunshine, there occur the most serious overpopulation, the greatest incidence of malnutrition and the least palatability in food. Pirie's far-sighted work may benefit the sunnier climates first, since the processing equipment would be no more complicated than a modern sugar factory.

In his paper, A. C. Thaysen discusses the scientific and economic aspects of food yeast, and he begins by showing that yeast is by far the most efficient known means of producing protein. He says "a fully grown bullock, weighing approximately half a ton, produces protein at the rate of 0.9 lb. per day of 24 hours. If half a ton of soya beans—one of the most prolific protein-producing plants known—be planted and grown under most favourable conditions and the beans be harvested, then their yield (calculated on a 24 hr. output basis) would be 82 lb. But, if half a ton of *Torulopsis* (the type of yeast frequently used in protein synthesis) were grown under favourable and technically possible conditions, then 51 *tons* of protein would be synthesized in 24 hours".

This highly efficient method of producing protein might be of the greatest importance if the world population were to outpace the present methods of food production. At present food yeast is a by-product of the sugar industry, but the sugar cane is one of the most efficient of the green plants, since it can produce over 50 tons of green material per acre per annum, far more than is produced by any other crop which is now grown on an economic scale. In view of this it is not impossible that sugar may one day become a by-product of the sugar cane, since it represents only about 12 per cent of the plant as a whole.

Dealing with the economic aspect of food yeast, Thaysen says, "Dried yeast, or food yeast, as the product of the two factories in Jamaica and South Africa is called, is to-day being sold at 1s. 2d. per lb. ex factory in Jamaica, and for a little less at the South African factory. One pound of food yeast contains 212 grams of protein, so that the cost ex factory per gram of protein works out at 0.069 pence per gram. For the purpose of comparison, I have assumed that 1 lb. of lean bone-free quarter of beef can to-day be bought for 6s. According to Bridges and Mattice, such beef would contain 90 grams of protein per lb., giving a cost per gram of beef protein as 0.8 pence". Thaysen admits that few people would prefer a thimbleful of dry food yeast to a tender steak, but only a very small proportion of the world population can afford to eat meat of any kind. Thus the future possibility for food yeast lies in adding protein to diets which are normally very deficient in it, and millions of people in Asia and Africa who live on rice or maize would benefit greatly from this addition to their diet, even though microbial protein is not entirely satisfactory as the only dietary source of protein.

One obvious nutritional possibility for food yeast would be as a supplement in animal feeding, but Thaysen points out that the present price ex factory of over £130 per ton makes it quite uneconomic. But he also says that present prices for food yeast are based on inflated post-war production costs, which are almost certain to drop when economic conditions are once more stabilized throughout the world. Further, technical improvements in large-scale yeast production may greatly reduce the cost of production, and it is probably too early to judge its economic future.

In recent years the possibility of synthetic food has been a subject for popular speculation, and W. F. J. Cuthbertson's paper on synthetic food potentialities summarizes the most recent knowledge of this subject. In the first place, it seems unlikely that the bulky components of a diet—starches, fats and proteins—could be synthesized on a scale which would materially affect the food supplies of the world. On a small scale, glucose has been produced from wood waste; fats have been synthesized from mineral oils; and amino acids, the breakdown products of proteins, have been synthesized chemically on a commercial scale. This "synthetic" glucose could be used in conjunction with ammonium salts for the cultivation of yeasts high in protein or fat, and this example of using an inedible plant substance for the production of food opens up a wide field for speculation. Cuthbertson says, "There are many difficulties to be overcome before most crop residues can be treated chemically to produce edible matter. They consist of extremely complex mixtures of macromolecular substances having poorly defined physical characteristics; further, their composition may vary over wide limits and is not well understood, so that it is not possible at the moment to speculate on chemical methods of using them. Should efficient processes be devised for growing them, then plant species giving high yields of total organic matter might well become a source of the inedible raw materials for a chemical food industry".

On the future of producing food products from coal and oil, Cuthbertson points out "when the progress of the human race is viewed against the geological time scale, it is clear that the most optimistic cannot expect our oil and fuel reserves to last for more than a few thousand years, even should we continue to dissipate them no faster than at present, a most unlikely contingency, for the rate of using these non-renewable fossil fuels is, in fact, rapidly increasing. Even should atomic energy offer a new source of power, its use would merely postpone the ultimate shortage of fossil carbon compounds suitable for chemical transformation into food".

Although it seems unlikely that the major foods will be synthesized economically and on a scale sufficiently large to avert any future world-wide hunger, the use of synthetic substances to fortify human food and animal feeds has already become commercially important. About ten different amino acids, and small amounts of at least a dozen other organic substances, vitamins and growth factors, must be present in the diet in order to ensure health and growth, and it is in this field that synthetic foods have found their place. Vitamins A and D are added to margarine in many countries, and in the Phillipines beri-beri has been eliminated by adding synthetic thiamine to rice. Vitamin D, "synthesized" from sterols, has been used increasingly during the last two decades in infant feeding and in stock rearing, and more recently synthetic vitamin A is being used to make up for a deficiency of this vitamin in grains used for meat production. In the United States of America synthetic vitamins of the B class are being added to feeds for pigs and poultry in order to reduce the amounts of fish meal, wheat offals, meat meal and milk products required in these rations. Thus riboflavin, used at the rate of 2 grams per ton of diet, has now replaced the 20–100 lb. of dried milk previously required; vitamin B_{12} decreases the amount of milk or meat and fish products when it is added at the rate of 5 to 15 milligrams per ton; pantothenic acid is added at 5 to 10 grams per ton to make up for deficiency of this vitamin in the basal ration, and nicotinic acid is used at 15 to 40 grams per ton when maize is a major component of the ration.

Cereals and legumes, the staple sources of carbohydrate and protein for pigs and poultry, are deficient in certain amino acids, particularly methionine and lysine, but these two substances can now be synthesized at costs low enough to encourage their use in animal rations based on maize and soya at the rate of ½ lb. per ton, and lysine is added at somewhat higher levels to improve diets based on wheat products and cotton seed. Cuthbertson continues, "These changes, brought about by practical application of synthetic chemistry and nutritional investigations, have led to great economies in the utilization of food for poultry and pork or bacon production—for instance, it is now possible to rear chickens to 4 lb. weight in 10 weeks on a total food intake of 10–15 lb. instead of in 12–13 weeks on the 16–20 lb. of food previously needed".

In the final paper of the series, P. N. Wiliams reviews the possibilities of producing synthetic fats on an economic scale, and he begins by pointing out that none of the processes known at present is likely to make a significant contribution to the world need for 18,500,000 tons of edible oils and fats per annum. The two processes which are best known were both worked out in Germany, one being a chemical synthesis of fat from mineral oil and the other a microbiological process. The chemical process was operated in a plant built in 1938 in the Ruhr, costing £1,250,000, but its maximum yearly output during the Second World War was only about 2,000 tons of edible fat. It is a somewhat complicated and very costly process, the fats had rather an unattractive appearance and taste, and there is some doubt as to their nutritional value as compared with natural fats. The process is no longer used in Germany.

The production of fats by the action of micro-organisms has been the subject of a great deal of research, but there seems no reason to believe that even the most successful procedure can produce fat at the present time as cheaply as that obtained from oilseed and fruit crops. On the other hand the fats produced by this method appear to be similar to natural fats in chemical composition and nutritional value, and they cannot be ruled out as future sources of food on account of their present costs of production. Several yeasts and fungi have been used successfully in small-scale production, with fat contents as high as 50 per cent of the dry end-product. The large space and labour requirements have been reduced somewhat by using submerged cultures, and the culture media—molasses, beer wort, and wood sulphite liquors—are all by-products of other processes, but are limited in supply or relatively expensive to transport. Technical improvements could cheapen the actual cost of processing, but the key factor in large-scale production is the availability of large quantities of a very cheap culture medium. It is obvious that, at present, sugar cane is the plant most likely to provide this material, so any future developments may possibly be carried out in sugar-producing countries.

These eight papers show that the possibility of world population overtaking world food supplies is not being overlooked by scientists, and, even though man may never be faced with the problem of world-wide starvation, research is leading towards more efficient utilization of the sun's energy and a higher nutritional standard throughout the world.

D. W. DUTHIE.

THE QUELEA THREAT TO AFRICA'S GRAIN CROPS

By John G. Williams, Ornithologist, Coryndon Museum, Nairobi

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In these times of rapidly increasing human populations all over the world, when the need to conserve grain crops becomes a vital necessity, Africa is threatened by a new plague to its cereal crops, a plague almost as serious as the great locust invasions of the past. The pest responsible for this danger to our economy is a small brown-coloured weaverbird, the dioch or quelea (*Quelea quelea*).

Kenya became aware of this threat only in 1952, when vast swarms of queleas appeared in the wheat-growing localities of the Rift Valley Province. Wheat valued at a conservative estimate of three-quarters of a million pounds was destroyed, and losses were also recorded from elsewhere in the Colony and from Tanganyika. The quelea menace has long been known in the Sudan where millions of pounds' worth of damage have been caused to native-grown grain crops. Extremely expensive control measures carried out there have failed to eradicate the pest. In southern Italian Somalia farmers in many areas have long since given up trying to cultivate rice, as their crops were entirely destroyed by queleas. This year Kenya has suffered no serious infestation for reasons which will be dealt with later in this article, but Tanganyika sustained very serious losses when native-grown crops were wiped out over a large part of northern Tanganyika, and lesser destruction was caused to European-grown wheat crops in the West Kilimanjaro area. Similar reports of serious crop destruction come from South Africa, the Rhodesias and various West African Colonies.

This avian pest may be recognized by referring to Plate 1 on which the various plumages of the quelea are portrayed. Fig. 1 shows the adult male in full breeding plumage, in which there is a strong suffusion of rosy-pink on the crown and underparts. Fig. 2 illustrates the adult male in non-breeding dress, when the rosy-pink suffusion is lost. The adult female in all plumages, Fig. 3, differs from the non-breeding male in lacking the blackish face and throat patch. Immature males and females closely resemble the adult female. The juveniles of both sexes resemble the adult female but have streaky crowns and paler pink bills.

In all plumages the quelea may be recognized by its red or pink bill, streaky sparrow-like appearance and shortish tail. It is a gregarious bird, almost always found in flocks, often in tens of thousands.

Many farmers appear to be unaware of the factors which control the movement of quelea swarms into grain-growing areas. In the first place it must be stated that under ordinary circumstances the quelea in large numbers is not a regular visitor to wheat areas and its appearances are spasmodic; normally it is a dry bush country bird which feeds on the seeds of various grasses. But it is a species which has the power of rapidly multiplying its numbers under favourable conditions—a succession of good rains producing a superabundance of seed-bearing grasses—and under such conditions it is able to produce a number of broods in succession, each averaging four young birds.

From data I have acquired over a number of years it appears certain that the quelea is polygamous, and statistics of flocks found in the breeding areas of northern Turkana, but not actually nesting, show that the sex ratio is approximately four females to every male. Estimating that favourable climatic conditions enable the birds to produce five broods during a year, a colony of 1,000 birds would increase to over 14,000 in one year, even allowing for a 10 per cent mortality which is probably on the high side. An examination of queleas killed from flocks invading wheat areas, the birds being picked up at random, not selected, shows that these flocks are composed of about 95 per cent immature birds (age confirmed by examination of degree of skull ossification) which seems to confirm that the quelea is able to increase rapidly over a short period thanks to its polygamous habits.

When a succession of good quelea breeding seasons is followed by drought conditions the dry bush areas are unable to support the increased population, which must then migrate or perish. It is then that the vast flocks make their appearance in the farming areas where they do so much damage. During my recent investigations in the Turkana region of Kenya I found that the average daily intake of grass seeds per bird averaged one-fifth of an ounce (dry weight). When feeding on wheat the quelea frequently takes only the wheat germ for food, discarding the remainder, hence even a relatively small flock of several thousands of birds has a considerable destructive potential.

It has been suggested that the present increase of queleas all over Africa is due to the fact that civilized man has begun to grow his cereal crops on a vast scale, and that the additional food and shelter provided by these crops have given the birds the chance to multiply with unprecedented rapidity. I do not agree with this supposition. For one thing queleas nest in remote thorn-bush areas, far away from any cultivated farmlands, where they rely on the endemic grasses for their food supply. In all the records available to me it is apparent that serious infestation of farming areas has always followed drought conditions in the birds' normal habitat. Even when an individual population is very large the birds do not seem to be attracted to the wheat areas so long as there is a sufficiency of grasses to provide them with food in the extensive dry bush regions they frequent. As an example, the quelea population in Kenya Colony is at present very large indeed, but no serious infestation has occurred this harvest, the birds having concentrated in those areas of the Northern Frontier Province and southern Italian Somalia where adequate rains have fallen. However there may be one exception to the general non-attraction of queleas to cereal crops under normal conditions: rice crops appear to have a specially alluring effect on the birds, and this crop may attract them even when there is grass seed available.

We have yet to learn what happens to queleas when their numbers exceed certain bounds. In all probability some disease breaks out among them and their numbers are reduced to a fraction. But before this happens they can eat and waste a great deal of the farmer's wheat.

Queleas are extremely irregular and unpredictable in their breeding habits. They nest in vast colonies, and one reported this month (but not yet confirmed) in the Northern Frontier Province of Kenya is reputed to extend for 30 miles! The nests (Fig. 5) are built in extensive stands of acacia bush with a thick undergrowth of grasses and herbs which affords building materials. Water must exist fairly near the colony, certainly within 30 miles. Unlike most other birds, queleas have no fixed breeding locality, although some areas are more favoured than others. It is far from rare for the birds to appear and breed in a region where none have nested for years. We have yet to understand fully the factors connected with the choice of nesting location, and this will have to be an object of research in the future. In their times of nesting queleas are equally erratic, and I have records of breeding in Kenya and adjacent countries taking place during February, April, June, July, August and November. In fact they may breed at any time of the year so long as weather conditions are favourable.

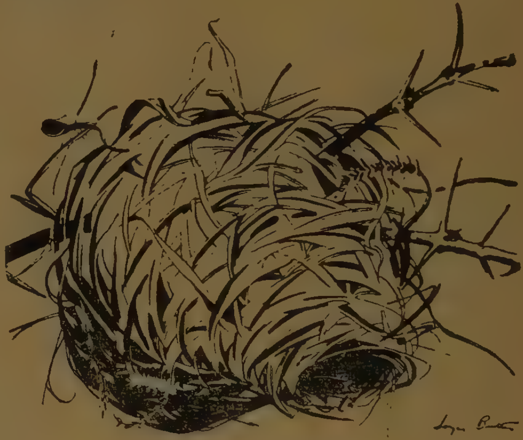


Fig. 5—Nest of Quelea.

Queleas become sexually mature in rather less than a year. Some immature specimens (probably hatched the previous June) which I collected near Nakuru in February already possessed enlarged gonads and would have been capable of breeding within three months.

So far as Kenya is concerned the data we have at present indicates that our main threat from queleas comes from breeding colonies in the north. It is pertinent to note that the quelea swarms (probably from breeding colonies in western Tanganyika) which attacked the west Kilimanjaro wheat area did not extend their operations into Kenya. The Kenya Rit Valley wheat areas are almost certainly invaded by queleas breeding in northern Turkana, the south-eastern Sudan, southern Ethiopia—especially the region of the Omo Delta—and eastwards to the Northern Frontier Province in the Moyale district. Birds breeding in the remainder of the Northern Frontier and in British Somaliland and Italian Somalia are a very real menace to any Tana River rice scheme and to the more easterly of the Kenya Highlands wheat zones. Birds reputed to breed in south-eastern Kenya Colony (this has yet to be confirmed) would probably not affect Kenya crops to any large extent; but would constitute a threat to the wheat areas of northern Tanganyika.

There is still a great deal we do not know concerning the movements and migrations of the quelea in East Africa, and further field studies of the species must include a large-scale ringing campaign. By this means the breeding regions of flocks invading our wheat areas may be determined, and long-term measures taken to reduce the birds in those regions.

The problem of quelea control falls into two categories, firstly the control and destruction of quelea swarms which have invaded wheat areas, and secondly the long-term control of queleas in their breeding haunts and normal dry bush country habitat. The latter control aims at preventing the build-up of quelea populations which cannot be supported in their normal haunts during dry years.

Experiments are still being conducted to discover an entirely satisfactory method of destroying large flocks of queleas which have already invaded farming areas—so far with only moderate success. Attacks on roosts, such as blasting them with high explosives and/or diesoline-petrol mixtures, have sometimes given fairly satisfactory results, but much depends on the nature and accessibility of the roost. When the birds congregate in numbers in a confined area this method of control may be very effective indeed, but as often as not the birds roost over a large area, for instance a bush-covered hillside, where they cannot be destroyed by these means. Some form of poison gas has been suggested for dealing with the latter type of roost, but this method of control has many drawbacks and would be extremely dangerous to the operators. Military-type flame throwers have been tried out in the Sudan against quelea roosts, but without much success. Apparently the birds are greatly startled by the brilliant light and most of them make their escape. Flame throwers can also be somewhat dangerous to operate: a report on their use in the Sudan concluded with the following words, "The experiment was not successful, the operator being burned to death".

In the drier farming regions, if queleas can be kept from other sources of water, a large-sized trap baited with water can be most successful. Details of such traps are given in a most useful publication entitled "Trapping Methods for Bird Ringers", by Mr. P. A. D. Hollom, and published by the British Trust for Ornithology, price 2s. 6d. Anyone wanting a copy of this booklet should write to the Secretary of the Trust, 91 Banbury Road, Oxford, England. These traps have yet to be tried out in Kenya. It will probably be found that their success will depend on the amount of surface water in the neighbourhood: in some of the drier parts of the Rift Valley Province they may well be most successful.

So far as Kenya is concerned I am convinced that the only effective method of eradicating the quelea as a pest to agriculture will be the long-term policy of continuous control of the birds' numbers in its breeding grounds (where this is possible) and in its non-breeding habitat. If the quelea numbers can be reduced and kept at a level able to be supported by food supplies in their normal habitat the species will cease to be a menace to our grain crops. It must be emphasized that this form of control will be effective only if carried out continuously for an indefinite number of years. Queleas will be quick to take advantage of any let-up in operations to establish themselves again in numbers.

The destruction of nesting colonies, although most desirable, may be very near to the impossible. Not only are such colonies extremely difficult to locate in the vast bush country of the northern districts, but during the rains when the birds are breeding the country is often impassable. An example of the difficulties of dealing with nesting colonies is illustrated by reference to a colony in the country south of Moyale. In a report on this colony, Mr. R. Matthews, of the Kenya Police, Moyale, writes: "Difficulties would arise if an attempt were made to deal with these colonies by physical action during the breeding season, if that is actually during the rainy period. During the rains no motor vehicles would move anywhere in that district. Even from a base at Moyale, and with luck, the nearest a motor vehicle could get to the site would be 20 miles away. There are large parts of the district surrounding the site where I consider it highly unlikely that even a foot party would get through: the soil of that district forms a deep, clinging mud for weeks on end".

In addition to the difficulties attendant on control of Kenya's quelea nesting colonies, other nesting colonies which affect Kenya agriculture exist in such inaccessible regions as south-western Ethiopia. However, birds from these breeding areas appear to move westwards or south-westwards after nesting, to concentrate on the grassy plains west of Kibbish Wells in the south-eastern Sudan, where they may be attacked and reduced.

At present we know little concerning the extent of quelea populations existing in British Somaliland and Italian Somalia, but there can be no doubt that flocks from these regions constitute a serious menace to cereal crops in the eastern half of Kenya, especially the rice cultivation scheme on the Tana. To determine the degree of quelea infestation Kenya can expect from these countries, and to find out under what conditions control measures could be carried out, I am undertaking a survey of the regions concerned during February/March, 1954.

Control of such nesting colonies of queleas as are accessible will probably be best achieved by blasting at night, but experiments will have to be carried out to discover the most efficient method of doing this.

Where control of non-breeding birds is concerned Kenya is in a much better position than most other countries—excluding possibly the Somalias where the problems of control are at present unknown—since in most of the dry bush country of the Northern Frontier Province and Turkana there is very little surface water during the dry season and the birds are dependent on such few permanent waterholes as exist. As the quelea is a species of bird which must drink every day very large numbers could be trapped easily at these water-points. The best type of trap to use for the capture of queleas would have to be determined by trial and error, but a modified funnel trap (Fig. 6) would probably be effective. A series of such traps erected on alternate days over water-holes at which queleas habitually drink would be certain to capture large numbers of the birds. This control method alone, so long as it could be operated throughout the birds' range in Kenya and adjacent areas, would reduce the quelea populations in a very few years to numbers which the dry bush country could support. The operation of these traps would have to be under very strict supervision to ensure that other species of birds caught in them would be released unharmed. Quelea flocks frequenting permanent rivers, such as the Juba, would not, of course, be trapped in such a manner, but it seems likely that such flocks would sooner or later move to attractive feeding grounds away from the rivers so that even their numbers would eventually be reduced.

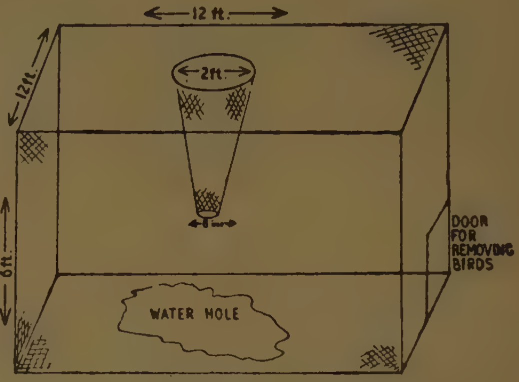


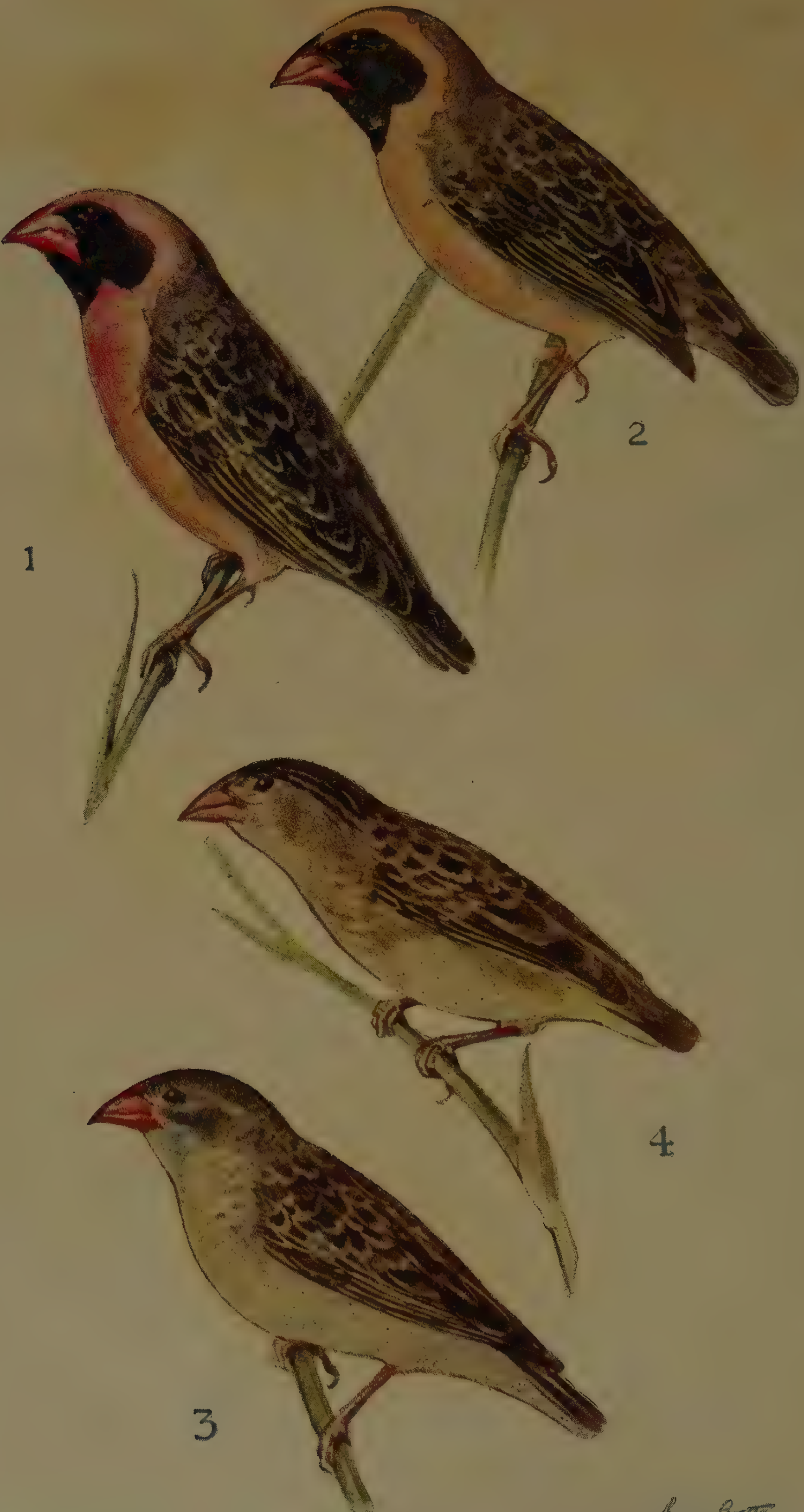
Fig. 6—Quelea trap for use over water holes.

To operate a successful quelea control plan in Kenya a minimum staff of four Europeans will be necessary, to work under the joint direction of officials of the Kenya Agricultural and Game Departments. Three of the personnel of such a staff would be field control officers stationed individually in Turkana with a base at Lokitaung, in the Northern Frontier Province with a base at Isiolo, and in Italian Somalia with a base at Lugh Ferrandi or Bandera. The duties of these officers would be entirely concerned with the destruction of queleas; they would be under the direction of the fourth officer who, in addition to organizing the control programme in the light of field experiments, would also undertake field research into the habits of the birds, operate a large-scale ringing scheme and carry out surveys as necessary.

It is satisfactory to note that funds have already been made available to the Kenya Agricultural and Game Departments for the purchase of equipment and transport for quelea control work, and the appointment of the first of the four officers needed will be made shortly. In other words the quelea menace in Kenya is being tackled. So long as financial support is continued, I am confident of the outcome.

ACKNOWLEDGMENT

Thanks are due to the Director of Agriculture, Kenya, for permission to reproduce Figs. 1–5 from a Departmental pamphlet entitled "The Sudan Dioch (*Quelea*) Investigation", by John G. Williams.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THE RELIABILITY OF RAINFALL WITHIN THE GROWING SEASON

By P. Robinson and J. Glover, E.A. Agriculture and Forestry Research Organization

(*Received for publication on 18th September, 1953*)

In this *Journal* (Vol. 19, No. 1, July, 1953) we showed how to calculate the reliability of annual, seasonal or monthly total rainfall. We now propose to show how a further simple extension of this method can be used to calculate the reliability of a pattern of rainfall within the growing season; that is, how to measure the reliability of any selected, suitable distribution of rain month by month within the season. Unless the distribution of rain within the season is suited to the crop, a knowledge of the reliability of the seasonal total is of limited value.

To illustrate this last point consider the rainfall at two stations, both in Tanganyika, one near Lake Victoria, the other near the coast. For the seven-month period November to May inclusive, the average over 15 years for the Lake Station was 32.3 in. while that for the Coast Station over a period of 13 years was 32 in. Without further investigation, the rainfall at both sites would seem to be suitable for selected grain crops. A determination of the reliability of the seasonal totals in both cases would support this view for the percentage chances that each would receive 15, 20, 25 or 30 in. of rain are almost identical as is shown in Table I.

TABLE I—THE RELIABILITY OF SEASONAL TOTAL RAINFALL AT TWO SELECTED STATIONS IN TANGANYIKA

Station	Av. rainfall in inches Nov.-May	Per cent Probability of obtaining at least			
		15″	20″	25″	30″
Lake ..	32.3 (15 years)	100	97.5	87.5	64.0
Coast ..	32.0 (13 years)	99.5	96.0	85.0	61.5

Even when monthly averages are considered both stations show similar patterns of rainfall distribution within the season (Fig. 1). Here, however, the first intimation is given that both are not equally suitable, for in the earlier part of the season the Lake Station has the higher averages, while the position is reversed in the latter part of the season.

If we now calculate the probability of receiving only 2 in. at least, in each of the seven months the differences are even more striking. We find that the Lake Station will receive this pattern (or better) 35 years in 100 whereas the Coast Station will receive it in only 12 years in 100. This somewhat startling result is, of course, due to the fact that although the total may be very reliable its distribution month by month within the season may be extremely unreliable. For example, in one year the Coast Station had a distribution as follows: November, 6.88 in.; December, 5.33 in.; January, 0.19 in.; February, nil; March, 11.30 in.; April, 10.45 in.; May, 6.47 in.; seasonal total, 40.62 in. Although its rainfall was above average for the season, the failure of the rains in January and February will exclude this season from those having a monthly reliability of at least 2 in. throughout. If the crop cannot withstand such a dry spell then the rest of the high rainfall may be of little value. The importance of estimating the chances of such failures is now obvious.

The method of calculating the reliability of distribution of rain within the season is simple. It depends on the assumption that one month's rainfall is not related to the next, or any other, i.e. that if you get a high rainfall in March you need not necessarily get a high rainfall in April and so on. We have tested the validity of this assumption for a number of East African stations and have found it to be a reasonable one. We have no absolute proof that it is true, for some slight dependence may exist which would only be revealed by a very long series of records and these, of course, are not available. Whatever the true state of affairs the possible slight dependence cannot seriously alter the results obtained by the simple calculations.

The method of calculation is as follows:—

1. Decide what distribution of rainfall is most appropriate to the crop. For example, a particular grain crop may require at least 2 in. in January, 3 in. in February, 4 in. in March, 5 in. in April and 2 in. in May.
2. Calculate the average rainfall and standard deviation for each of the selected months, in the above case for each of the months January–May inclusive, as was shown for seasonal data in the previous paper.
3. Use the average and standard deviation for each month to calculate the probability of receiving at least the level of

rainfall selected for that month. For example, in the above pattern use the January data only to calculate the probability of receiving 2 in., the February data to calculate the probability of receiving 3 in. and so on.

4. The probability that the season will have at least the selected pattern is then obtained by multiplying all these calculated probabilities together.

A worked example may explain this more clearly. We will use the pattern of distribution referred to above and show how it is calculated for the Lake Station. Table II shows the means and standard deviations for each month. We have not shown the calculation of the standard deviations for that has already been shown in detail in the previous paper.

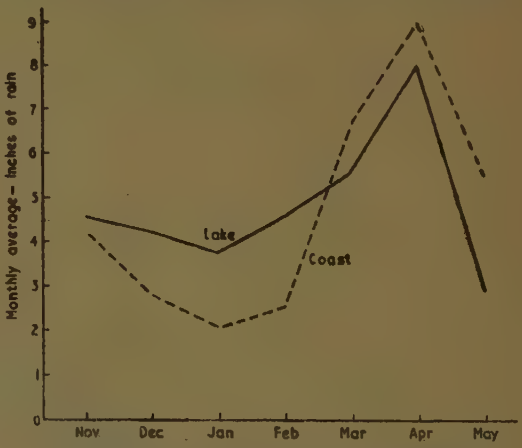
TABLE II—THE ACTUAL FALLS AND THE MEANS AND STANDARD DEVIATIONS FOR EACH OF THE FIVE MONTHS DURING THE GROWING SEASON FOR THE LAKE STATION

Year	Jan.	Feb.	Mar.	Apr.	May
1951	4.09	7.70	10.26	12.64	1.82
1950	2.41	3.40	6.90	6.11	1.30
1949	3.46	2.37	1.06	5.35	1.24
1948	4.68	2.06	6.00	10.31	1.44
1947	4.90	4.46	4.96	6.75	2.75
1946	3.41	3.32	1.25	12.75	1.25
1945	2.27	2.68	3.03	6.60	6.37
1944	4.22	3.52	6.11	6.46	4.37
1943	1.87	3.38	5.32	4.68	1.56
1942	5.04	5.10	6.75	10.16	1.83
1941	4.16	10.46	5.14	3.90	2.92
1940	4.88	7.34	3.79	8.04	7.76
1939	5.08	3.69	9.37	13.28	1.16
1938	1.75	5.55	8.45	7.59	2.49
1937	6.28	6.43	6.89	9.43	4.24
1935	1.85	4.78	3.61	5.22	2.48
1934	3.07	1.96	6.05	6.93	1.57
Mean 17 years ..	3.73	4.60	5.58	8.01	2.74
Stand. dev. ..	1.36	2.30	2.54	2.93	1.91

For January the selected level is 2 in. so the standardized difference is $\frac{3.73-2}{1.36} = 1.27$ which corresponds to a probability of 10.5 per cent*. This is the probability of getting less than 2 in. The probability of getting *more* than 2 in. is the difference between this and 100 per cent which is 89.5 per cent. For February the selected level is 3 in. which gives a standardized difference of $\frac{4.60-3}{2.30}$ or 0.70 which corresponds to a probability of 24 per cent of obtaining less than 3 in. or 76 per cent above 3 in. Similarly for March the standardized difference is $\frac{5.58-4}{2.54}$ corresponding to a probability of 27 per cent of obtaining below 4 in. and 73 per cent above 4 in. The April values are given by $\frac{8.01-5}{2.93}$ which gives the probability of being below 5 in. as 13.5 per cent and above 5 in. as 86.5 per cent. The May values are given by $\frac{2.74-2}{1.91}$ which gives the probability of being below 2 in. as 35 per cent and above 2 in. as 65 per cent.

As we wish to measure how often the rainfall will be at or higher than the selected levels month by month throughout the season, the corresponding probabilities are multiplied together. For the five-month period under consideration these are 89.5 per cent, 76 per cent, 73 per cent, 86.5 per cent and 65 per cent respectively so the probability of obtaining the selected pattern is $\frac{89.5}{100} \times \frac{76}{100} \times \frac{73}{100} \times \frac{86.5}{100} \times \frac{65}{100}$ which is 27.9 per cent. Thus, in about 28 years out of 100 there will be seasons in which the rain month by month will be at or above the selected levels.

We have here given the ratio as about 28 years in a period of 100 years, and one can legitimately ask why we did not say about three years in ten, because no farmer has records of 100 years, whereas most have ten, and they can then check up on the accuracy of the calculations. We have intentionally made



Average monthly rainfall for seven months at two selected stations, showing the similarity in seasonal pattern.

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* The Table of Probabilities and its use are given in the previous paper (this *Journal*, July, 1953).

the period a long one because there is then time for the *average* result to be observed, whereas with periods of only ten years there could be as many as five good seasons or as few as one, without doubts arising as to the accuracy of the calculations or the efficacy of the method. For this reason, although we accept ten-year records as suitable for a preliminary estimate of the probabilities, we prefer to use a longer series if possible. Those farmers with long records of rainfall are in a better position to estimate the reliability of their rainfall than those who have short records. In some cases it may be possible to use long series of records from a nearby railway station if the farm's records are scanty, for if the rainfall on the farm is similar to that at a nearby railway station over a short period, then an estimate of the probabilities of a good season may be derived from the longer railway records.

LETTER TO THE EDITOR

A HEIFER HATCHERY

DEAR SIR,

Replacing stock by heifers of good production heritage is tremendously important for every dairy farmer. Although most Midwestern dairymen prefer to raise their own heifers some big operators sell day-old calves and depend on buying mature cows for replacements. This practice is particularly common in California. It is almost impossible to improve production of a herd where this kind of program is followed. It is also difficult to control brucellosis, mastitis and all the rest of the common dairy cattle diseases.

Some operators of larger dairies located in close proximity of the Los Angeles metropolitan area have decided to prevent such a loss of potentially good breeding stock. Taking a leaf from the pig hatchery experiences, they naturally asked themselves whether something like a heifer hatchery would be possible. The distance between idea and action was not very long and a new trend has started. Quite a few dairymen contract the growing out of heifer calves from their producing cows with a calf nursery. They turn day-old calves over to a man who has adequate pasture, equipment and experience in raising calves. When the hatchery is through with its job, the dairyman gets a bred heifer back.

[*Photo: Wallace Sullivan*

Individual stall where calves are kept till 4–6 weeks old.

The Agricultural Extension Service at the University of California has been very much interested in this new development and is helpful in supplying all the information on "How to become a calf-raising wizard". New techniques and methods, such as artificial insemination, better understanding of sanitation and calfhood diseases, new knowledge of feed and nutrient requirements contribute all towards making a heifer hatchery a successful business.

Yours faithfully,
FRANK MEISSNER.
28-7-53.

Agricultural Experimental Station,
University of California,
U.S.A.

A PRACTICAL GUIDE TO COCO-NUT PLANTING

By W. R. Sethi, Assistant Agricultural Officer, Department of Agriculture, Kenya

(Received for publication on 18th September, 1953)

Selection of Land

When there is good rainfall coastal alluvial loamy sands are well suited for the cultivation of coco-nuts. When choosing a site for planting special attention should be paid to surface drainage which, from my observations, is more important than sub-soil drainage, although the latter is of considerable importance as well. The growth of the tree, the colour of the fronds, and the size of the fronds are governed to a very large extent by the water supply in the soil. Swampy land should never, under any circumstances, be chosen as a planting site. Regard must, of course, be paid to the accessibility of the site in order that transport should be easy and inexpensive but this, of course, does not apply to the African peasant grower.

The Preparation of Land for Planting

If the land is comparatively low-lying, and some of the soil is of a peaty nature, which is very often found to be the case in coastal regions where rich alluvial loam exists, drains should always be put down to ensure good soil drainage. Where the ground is higher, and there is no possible chance of it becoming flooded during the rainy season, this precaution will not be required. All bush and trees should be cut down and burnt and the land well prepared before planting.

Selection of Seed

The greatest care should be taken in selecting the seed in order to ensure, as far as possible, that the plantation will eventually consist of only good, healthy and vigorous palms of uniform yielding capacity.

In the first place the seed should be collected from palms which are bearing well, not only at the time of collection, but ones which from previous records are known to be good yielders. The owner of a coco-nut plantation will usually help to select good yielding and healthy palms. In addition selection should be made from palms between 20 and 40 years of age and, preferably, only fair-sized and well-shaped nuts should be chosen. Very large nuts and those of a particular oblong shape are better to be avoided since generally they will give fewer nuts on the spathe and the ones of oblong shape usually contain a smaller proportion of kernel than the rounded nuts.

Proper precautions must be taken to see that the nuts are fully matured before being collected from the tree and any nut showing the slightest damage should be discarded. After picking the nuts it will be found advantageous to keep them for a short time to allow them to harden so that the husk may be thoroughly dry before being put down in the nursery.

Nurseries

In my experience nurseries under natural shade are preferable to those in the open sun or to those having artificial shade. It is a very common practice amongst Africans to lay out the seed nuts under the over-lapping roofs of their houses and here the nuts get water from the roofs whenever it rains.

The better course, however, in my opinion, in order to allow the seed the best chance of sprouting and making a good start, is to lay out carefully prepared beds on good soil.

The nuts, after the beds are prepared, should be placed in rows 2 ft. apart, and be half buried in a slightly slanting position with the acute end of the nut downwards. If found to be too much exposed the nuts should be shaded for a time and the shade be gradually lightened, so that the nuts may harden with exposure to the sun before they are transplanted in the field. The nursery should have a fence round it, to protect it from livestock.

Planting the Seedlings

On the coast the best distance for planting the young seedlings is 30 ft. by 30 ft., but if annual crops are to be interplanted the distance should be 40 ft. by 40 ft. If the land is level or high enough pits should be dug at the distance mentioned and some coco-nut husks should be put in them first. Then the pit should be filled up with good soil ready for the seedlings: the pits may be square or made in circular form; the larger the hole the better, but one not less than 2 ft. in diameter and 2 ft. deep is essential. The nut from which the seedling sprout has come should be just on a level with the surface. On low-lying land the nut should be placed on the surface with only the root put in the soil, and good top soil should be moulded up round it to make a mound 3 ft. to 4 ft. in diameter. As the mound subsides moulding has to be done repeatedly. It may be necessary to stake each plant with two strong sticks to prevent damage by wind.

Deep planting should never be done no matter how well the land is drained as, even on well-drained soil, excessive moisture may cause the death of seedlings planted in this way.

From the writer's experience on the coast there can be little doubt that the best age for transplanting the seedling is from three to five months. At this age the roots can, with care, be easily dislodged from the ground with very little damage. This is very important for ensuring the chance of a good start for the seedling. There is also the advantage of the nut, at this stage, having plenty of nutrient on which the seedling can subsist until it has thoroughly established itself. When the seedlings are retained in the nursery until a much later stage, they will be difficult to transplant as the roots are often damaged or broken off during the process. This gives a check to the seedlings from which it may take them several months to recover. In addition bigger seedlings are more difficult and expensive to transport. Planting seed at stake can be a great success if theft can be avoided, since the sprouted plant will progress without any disturbance and without restriction of food supply from the nut or the soil.

Maintenance and Cultivation After Planting

On the coast those coco-nut growers who have long practical experience of coco-nut growing have found that the most critical time in the life of the coco-nut palm is in the early stages. A future life of vigorous growth and heavy production depends very largely on a good beginning. Therefore in the first three or four years careful attention and closer supervision than usual is needed.

It is preferable that clean weeding should be done until the palms have reached the above age as no grass or noxious weed of any kind should be allowed to share the food from the soil.

To protect the feeding surface roots, to keep the soil in a friable condition, and to enable the young palms to take advantage of the moisture prevailing around the plant, it is necessary that the ground should be loosened by digging at least once in every three months. Mulching with coco-nut husk and grass is very beneficial for the well-being of the plant. An area of a radius of 3 ft. to 4 ft. from the stem of the young palm should be treated in these ways for the first one or two years. Thereafter, as the palm grows, the area treated should be increased until at maturity and full bearing, an area of 8 ft. to 10 ft. radius from the stem will be treated. When the palms are full bearing green manuring, by leguminous crops such as velvet beans or cowpeas, should be started to encourage good crops.

Interplanting of Catch Crops

For African growers interplanting of coco-nuts with other crops is, to some extent, necessary. Interplanting depends upon the nature of the soil and the spacing of the coco-nuts.

Such crops as bananas, pineapples, groundnuts, Bambarra groundnuts, green gram cowpeas and various other legumes can be grown provided the soil has plenty of humus. The cultivation of bananas and sweet potatoes among young coconuts has been very successful provided moisture conditions allow. The weeding trouble is thereby reduced and humus and moisture conserved by shading and the return of vegetable matter to the soil.

Recently it has come to light that cashew, citrus and mango trees, interplanted with coco-nuts, are very beneficial as they increase the number of *maji moto* ants. These ants are parasites of the Coreid bugs, attack by which causes the fall of immature nuts.

Gathering and Storing the Nuts

There are normally six collections in the year, the practice on the Coast being to collect the ripe nuts every two months. The nuts are either collected by professional collectors who charge 10 to 15 cents per tree or are paid in kind at the rate of one nut per tree, or the collection may be done by the farmer's young sons. The collector simply climbs the tree and selects the ripe nuts. Because of the slipperiness of the palm trunks collection is usually done only on dry days. The right thing would be to let the ripe nuts fall and be collected on the ground but theft is too frequent nowadays to make this a practical method.

As the nuts are being collected they should be gathered together in heaps and the husk removed before the nuts are taken to the place where the copra will be made. The benefits of this procedure are a saving of transport and the husks can be used for mulching purposes in the field. Any storing for long periods will require to be done in the husk.

The writer has observed that the time from blossoming to maturity of the nut is 11 months.

Preparing Copra for Market

The method of husking, using a sharp-pointed spike, requires little description since it will be familiar to all. It is the universal method on the coast. A small machine has been imported at Gazi by Mr. Jafferali Lalji but it has not proved an unqualified success owing to the variation in the form and size of the nuts. It is usual at Gazi for a good labourer to hand husk from 600 to 1,000 nuts in an ordinary working day.

After husking the nuts should be moved to a drying place and split open in halves and the drying commenced on the same day. On the same day the husking and splitting operations must invariably take place since if the husked nuts are allowed to split open by themselves, as they will do if exposed to the sun for any length of time, mouldy and dirty copra will result. Drying should continue for about six days after the kernels have been removed from the shell.

The average return of copra from the nuts is a frasila (36 lb.) from 100 nuts, while our best estate on the coast at Gazi is producing a frasila of copra out of 80 nuts. Badly-managed African plantations may produce as little as a frasila of copra out of 120 nuts. It is easy to see that for success in copra-making much hard work and close attention is needed.

Manuring the Coco-nut Plantations

Where cattle manure is available that is the most suitable manure for coco-nut plantations under local African management. Artificial manures should be left alone for a very considerable time to come. For non-African farmers it must also be borne in mind that the application of artificial manures might sometimes be done to bring palms on poor soil into a healthy condition again. Unfortunately little is known about the use of fertilizers on coconuts in coastal areas.

However it is definitely my opinion that every African plantation owner should have a herd of cattle or sheep, where that is possible, for grazing through the plantation. Green manuring with leguminous crops for the bearing trees is very beneficial and also there is manurial benefit from mulching with the husks. The plant nutriments, nitrogen and potash, produced in quantity from the legumes and the husks, are the main requirements of the coco-nut palm.

Pests

In all kinds of agriculture, tropical or otherwise, we are brought face to face with pests and disease at every stage of development. Coco-nuts are no exception.

Rhinoceros Beetles.—The most common and at the same time the most harmful of coco-nut pests are the rhinoceros beetles. Much has been done in Kwale district, more perhaps than other districts on the coast, towards stamping out of the beetles by carrying out a systematic attack on the breeding places, that is, by cutting down dead and dying palms and later burning them. In four years about 30,000 dead and drying trees have been destroyed. The breeding places have thus been controlled to a large extent but continuous work is necessary for success. Other breeding places may be found in the Borassus palms, the Doum palm, in sawdust, paddy husks, and in refuse heaps of all descriptions. The grub or larvæ may be found in thousands in quite a small heap of dung. When the beetles reach maturity they leave breeding grounds and it is then that they go to the coco-nut palms and commence their ravages. The place of attack is slightly above or near the top of the cabbage from where they bore their way downwards laying their eggs at the end of the holes so formed. Owing to their constant and continuous onslaughts they do great damage to the trees, nipping with their mandibles the embryo leaves. They also attack the stem that bears the fruit just at the time when it is forming and the stem is often killed outright. If it does manage to shoot out, it probably will bear little or no fruit.

When the beetles appear in any number it is evident that there must be some breeding grounds about. The first thing to do is to search out and destroy all the haunts mentioned before, and everything in the plantation likely to harbour the beetles should be burnt. Special attention should also be given to the young trees. In them the beetles, in the first place, may be found on the leaves themselves and here they are easily collected and killed. If, however, the beetles have already found their way into the "cabbage" of the palm, they should be dealt with by taking them out with a stiff piece of wire about 18 in. long with a barb on the end of it. The beetle should be destroyed and the holes filled with a mixture of sand and Bitumen R.C.2, or any other kind of tar. It also pays to extract the beetles every two months at the times of collection of nuts in this way even from mature trees.

Coreid Bug of Coco-nuts.—Although this pest is suspected of having done considerable damage in the past, its presence was not noticed (due to its size and habits) until comparatively recently in Zanzibar. It has now been found on the mainland and it is considered to be of sufficient importance as to warrant special study. To date there are no proven methods of control.

THE PREPARATION OF CROCODILE SKINS FOR EXPORT*

By I. Mann, Department of Veterinary Services, Kabete, Kenya

(*Received for publication on 20th November, 1953*)

East African crocodile skins are in great demand and fetch high prices on the world markets. Within the last six years the export value has risen very considerably, as shown from the following figures:—

	Cwt.	*Value* £
1947	22	62
1948	1,049	14,105
1949	1,477	18,133
1950	6,381	102,814
1951	7,870	181,857
1952	3,368	120,162

Unfortunately only a small proportion of the skins from the many crocodiles caught are sufficiently well prepared to reach the export market. The rest, badly damaged through cuts, bad shape, scale-slip, putrefaction or "red-heat", are a direct loss to the trade. On account of the great demand and very high prices prevailing for good crocodile skins, many hunters have in recent times attempted to make their living by the destruction of crocodiles, without a proper knowledge of the handling and curing of their skins.

The aim of this article is to explain, in as simple a manner as possible, how to treat the skins so that they reach the tanners in good condition and obtain the best price. Although it is commonly believed that crocodile skins are so strong that they cannot be damaged in the same way as cattle hides or goat and sheep skins, this idea is erroneous. Not only can they be rendered completely useless through improper handling, but they require even more careful treatment, since direct sunlight causes a condition known as scale-taint. Normal air drying, as carried out with hides and skins, cannot therefore be applied to crocodile skins. The only way of preserving them is by salting.

Various methods are employed in capturing crocodiles. These depend on the local conditions and the skill of the hunter. Whether shooting, netting, harpooning, noosing, drowning with a weight, poisoning, blinding with a torch, pole-axing, trapping or baiting on a hook, is employed, the following rules must be observed:—

1. No damage whatsoever should be caused to the belly part of the skin. As this portion of the skin is the only marketable part of the crocodile, wounds, spear and harpoon marks, bullet holes or any other injuries, which occur during the killing and securing of the animal must be restricted to the head and back of the body.

2. The carcass should not be left in the water for more than eight to ten hours. The ideal, but not always possible way is to remove the crocodile from the water as soon as it has been killed. Underwater damage by cannibalistic crocodiles rarely occurs. Nibbling by fishes does occasionally cause a small amount of damage. The main damage is caused by putrefaction, which, especially in shallow, warm water in lagoons, sets in very rapidly. On no account should the carcass be left in the water until it "blows" and floats to the surface, as skins from such carcasses, although they may not show substantial damage during flaying, are useless to the tanner.

3. When the carcass is removed from the water it should be dragged out so that the back and not the belly comes in contact with the ground. If this is impracticable, great care should be taken when landing the carcass from the water, especially on rough and stony ground. In order to avoid damage to the scales through dragging, the landing place should be cleared as far as possible of sharp stones and the carcass should be dragged over a layer of cut vegetation such as papyrus, reed or grass.

4. No time should be wasted between flaying, fleshing and salting. From the moment the carcass has been landed until the skin is salted, speed is essential, not only because of the danger of putrefaction, but also because the skin dries out and hardens rapidly and will not absorb the salt.

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* This is the text of a bulletin which will shortly be published (in English and in Kiswahili) by the Department of Veterinary Services, Kabete, Kenya, and will be available from the Government Printer, P.O. Box 128, Nairobi.

5. The skin should never be exposed to direct sunlight as this is very detrimental to the skin, not only because it dries out rapidly but the scales take on an oily, transparent appearance and this condition interferes with the tanning.

Only the belly part of the crocodile skin can be converted into leather, whereas in the case of other animals the whole skin or hide is used, the back being the most valuable and the belly the least. The reason for this is that the back is covered with very hard body scutes, which are horny and useless to the tanners.

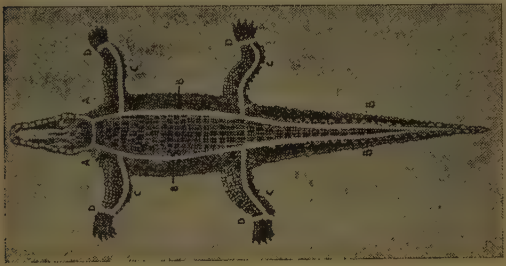

Fig. 1—Ripping Lines.

The main aim of the hunter should be to obtain a properly shaped belly skin, from the snout to the tip of the tail, including the legs. It should be taken off symmetrically, achieving the fullest possible width. Correctly-shaped "bellies" can only be obtained by using basic incisions, called "ripping lines". To prevent damage to the "belly" during flaying and other operations, two rows of horny scutes should be included. The basic incisions should be made as follows:—

Head.—Separate the skin on the neck from the body under the hard disc on the top of the neck. Cut downwards inside the jaw, near the jawbone and along the lips until the two cuts meet at the front. (*See* A on Fig. 1.)

Body.—Make two long incisions from the back of the head and along the body. These cuts should start at the initial cut and end at the tail fin. Two rows of scutes should be left on each side. (*See* B on Fig. 1.)

Legs.—The legs should be opened in the following way: Hold the leg firmly at the "wrist" and pull it out away from the body; make an incision in the middle of the top of the leg from the main ripping line over the point of the elbow to the "wrist" (*see* C on Fig. 1); cut around the "wrist" as near to the foot as possible (*see* D on Fig. 1). This will produce a piece of skin having light-coloured scales surrounded by an even, dark edging. It is most important when opening up the legs, to cut through the skin *over the point* of the elbow, otherwise a "pocket" will be formed. This is a defect which affects the price on grading.

Tail.—It is possible to get the skin off the tail by working downwards from the main ripping line, but it is better to gain access by cutting out a triangle, the line between the hind legs being the base and the tip of the tail the apex. Remove the triangle and this will facilitate access to the tail piece. In large crocodiles, over 7 ft. long, the last 6 to 8 in. of the skin from the tail can be pulled off, but in smaller specimens the skin must be separated with a knife right up to the tip.

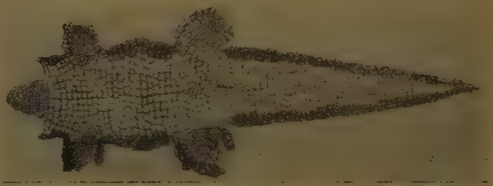

Fig. 2—Properly Flayed Belly. Obtained by using ripping lines shown on Fig. 1.

When flaying, one should pull the skin away from the body with one hand and the knife should cut through the connecting tissue only, so that the skin is not damaged by cuts and scores.

PREPARATION

Fleshing.—As soon as the skin has been separated from the carcass it should be placed on a completely flat surface and any surplus meat, fat or tissue scraped or cut off. Any meat or fat left adhering to the skin will hinder the penetration of the salt.

To avoid damage, skinning and fleshing should be done with curved skinning knives. A very good scraper can be made from a piece of hoop iron 1 in. wide, fastened in the form of a hoop to a handle, as shown in the illustration. (Fig. 3.) The edges of the iron are sharpened with a file. This operation should not be overdone or thinning of the skin will result.

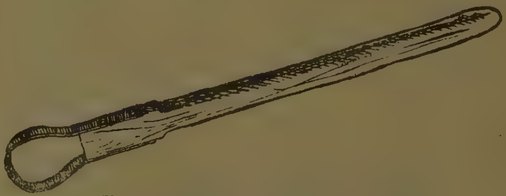

Fig. 3—Scraper. Used for fleshing.

Trimming.—By use of the proper ripping lines the correct shape is obtained. Nevertheless, it is wise to trim off loose skin and to round off any corners, so that the skin has a perfectly symmetrical shape.

Washing.—As blood and dirt interfere with the salting, the skin should be thoroughly washed, preferably being scrubbed with a brush while water is poured over it from above. It is not a good practice, as is often done, to drag the skin back into the water for washing, as in this way it gets soiled with mud and vegetation.

First Salting.—Salting is the most important and intricate operation and therefore the greatest care should be taken. Firstly, the salt itself must be clean, dry and free from earth, blood, etc. Only fine salt should be used, as coarse salt does not give good penetration. The salt is rubbed very thoroughly and evenly into the wet skin on the flesh side only. It is a great mistake to allow the skin to dry first and then to rub in the salt as it will not be absorbed and will dry out in the form of a crust on the surface.

Draining.—By putting the skin in the shade and draining off the brine, a great part of the skin moisture can be removed immediately after the first salting. The skin can be put over poles or better still on a wire rack, as shown in the illustration. (Fig. 4.) The flesh side should always be uppermost. Great care must be taken that no direct sunlight beats on the skin.

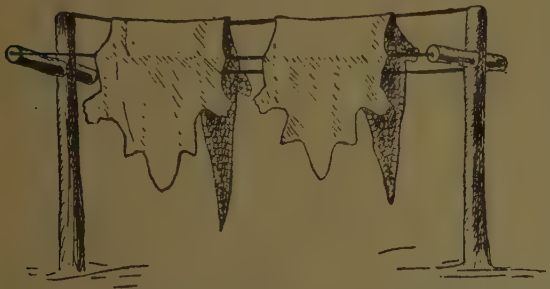

Fig. 4—Draining Rack. This consists of two uprights, 5 ft. high, placed about 10 ft. from each other. Two cross poles, 2 ft. long, are fixed 1 ft. from the top of each upright. Wire is stretched from the top of one upright to the other and from the extremities of the opposite cross pole. To keep the uprights vertical and rigid under the weight of the skins, a horizontal pole is firmly fixed between them about 2 ft. 6 in. from the ground.

Second Salting.—The draining should take not more than one or two hours and then the second salting can commence. Before the second salting, it is as well to flesh the skins again, since the first salting makes apparent more meat and fat which was not visible during the first operation. New salt is rubbed in very thoroughly and evenly.

Transport.—After these two preliminary operations the skins can be removed to a godown or storehouse for final treatment. They should be rolled, scales inwards, with abundant salt for transportation. Care should be taken that not more than three skins are put one on top of the other, otherwise damage from heat and pressure will occur. During transportation the skins should be protected from dust or rain with a tarpaulin, or, if this is not available, with sacks or at least with a layer of grass. This will also give protection against excessive drying out.

Curing.—Curing is best carried out in a cool shed, store or hide godown and not on the shore. The aim of curing is to prevent bacterial action and to preserve the skin until it reaches the tannery. During curing the natural moisture of the skin is replaced by concentrated brine which inhibits the growth of bacteria. This is the most difficult operation and will affect the condition in which the tanner receives the skins as much as six months later.

If decomposition occurs the first indication is a loosening of the scales. This is called "slipping" and the effect "scale-slip". Scale-slip may occur at any time after the skin has come in contact with water, i.e. rain from a leaking roof or during transportation, or it may be due to the use of too little or bad salt. It occurs mostly in the folds. If scale-slip is not arrested it will penetrate deeper into the skin and cause putrefaction.

In order to avoid "red-heat", which is a red coloration of the skin caused by fungi, it is advisable to add a preservative to the salt used for curing. Very good results can be obtained by mixing ½ per cent Santobrite (Monsanto) with the salt. This chemical should be mixed very evenly with the salt before use. To get the correct proportion, add 1 lb. of Santobrite to 200 lb. of salt.

In the curing process, the old salt is first completely shaken off the skin. On no account should the skin be placed on murram or earth, but on a concrete floor or wooden platform. The platform or concrete floor is covered with a layer of 1 in. to 2 in. of salt, and the first skin is placed scale side downwards on the salt; the flesh side is covered with a 2 in. layer of salt and additional layers of skins are added in the same way; i.e. a layer of skins, scale side downwards, covered with a layer of salt. In this way a "pack", not more than 2 ft. high, should be made, otherwise damage through pressure may result.

It is better to use too much salt than too little. Too little salt may cause rapid drying out or "red-heat" in the parts not completely covered with salt. After the pack is completed the top surface is covered with a thick layer of salt to prevent drying out.

The temperature of the room in which the skins are being cured should not rise too high. The curing shed should, therefore, be high-ceilinged and properly cross-ventilated. Should the roof be of corrugated iron, matting should be laid over the iron to prevent excessive heat. The roof should be impervious to rain. A very windy, draughty place will cause unnecessary drying out.

It takes about three weeks to cure the skins and prepare them for shipment. As the bottom layer of skins becomes cured most quickly, it is advisable to alter their position after ten days. This is done by placing the top skin on the floor beside the first pack and building a new pack with the skins in reverse order. The same salt can be used provided no red colouring is observed. This should not occur if a preservative is used.

It must be reiterated that direct sunlight is harmful to crocodile skins at every stage from the capture of the animal until their arrival at the tannery. Even cured skins should never be exposed to direct sunlight.

Packing for Shipment

At this stage the skins are properly cured and the danger of putrefaction is considerably reduced. Nevetherless, a little new salt should be added when packing for shipment as the skins, if left without salt, would be liable to dry out or absorb too much moisture, depending on the climatic conditions during shipment. For instance, they would dry out during transit by rail through a dry, hot region and become too wet during a sea voyage, unless this salt was added.

The skins are first removed from the pack and the salt is shaken off them, without beating, as this procedure may damage the skins. They are placed flat on a large table or concrete floor and inspected. It may be necessary at this stage to trim off uneven parts from the edges to give the skins a symmetrical appearance. Each skin is now evenly covered with a little fresh salt, rubbing not being necessary, as cured skins will not absorb salt. Each skin is then folded, as shown in the diagram. (Fig. 5.) First the sides are folded along the lines A–A; then the head is folded in along the line B; and finally the tail along the line C. Sufficient salt should be placed in all the folds of the skin. The skin is now in the form of a neat rectangle and has to be rolled from the tail end towards the head and secured with a piece of string. Some exporters do not fold in the head and tail, but roll the complete length from the tip of the head to the end of the tail. A tie-on label should indicate the origin, grade of the skin and name of the exporter.

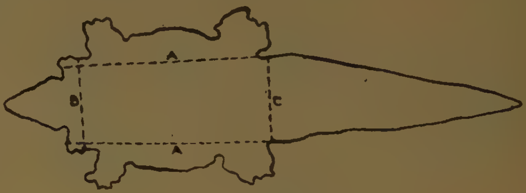

Fig. 5—Folding.

The skins can now be packed in clean sacks. They are placed one on top of the other until the sack is tightly filled up to three-quarters of its capacity. The sack is then closed and placed in another sack, which is finally sewn up. In this way a double thickness of sacking gives the necessary protection against drying out. For the same reason it is important that hessian sacks are used; sisal sacks are not recommended as they are too loosely woven.

The bundles of skins ready for shipment should not be exposed to the sun, rain or draughts. They should not come into contact with rusty iron nor is it advisable to store them for longer than necessary.

Although the above method gives good results, crating is preferable, in spite of heavier costs. Care should be taken that no nails penetrate into the crate, which should be well lined with sisalcraft. The rectangular-folded (not rolled) skins are packed very firmly, so that there is no possibility of any movement which might cause damage by friction. Packing should be such that no spaces are left either in the corners or at the top before the lid is nailed down. Up to 1,000 lb. weight of crocodile skins can be packed in this way in one crate, which is strengthened with three or four bands of hoop iron.

Defects Affecting Grading

Grading of crocodile skins is even more difficult than grading hides and skins from domestic animals, and only by experience and continuous practice can the necessary skill be achieved. The main defects which affect grading are "buttons", damage during life, damage during flaying and fleshing, damage due to exposure to sunlight and damage during curing and storage.

Buttons.—Crocodile skins are divided into two main classes: "with buttons", and "without buttons". The buttons are hard, bony rectangular deposits inside the skin and are hardly visible, but they can be felt by hand. (Fig. 6.) It is not known why crocodiles develop these buttons in certain localities, but some theorists have suggested that they are caused by lime salts in the water; that they are due to the environment in which the animals live, e.g. hard ground; or that they are inherited, since they are peculiar to certain types.

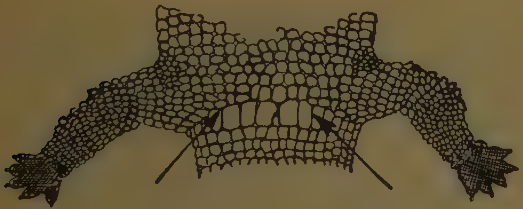

Fig. 6—Showing Places Where Buttons Begin.

The percentage of "buttoned bellies" varies approximately as follows:—

	Per cent
Lake Victoria	8 to 10
Lake Rukwa	35 to 40
Lake Rudolf	50 to 60
Pangani and Sabaki Rivers	10 to 12
Tana River	8 to 13
Athi River up to Tsavo	Nil

Buttons do not occur in very young crocodiles. They usually start in crocodiles measuring 7 ft. to 8 ft. However, in lakes where the occurrence is high, such as Rudolf and Baringo, the buttons may be found in crocodiles as small as 4 ft. in length. Buttoned crocodiles are not wanted by tanners and, therefore, the skins fetch a very low price. Many importers will not buy even the best "buttoned bellies".

Damage During Life.—Three kinds of damage which may occur during life can influence the grading: (i) sores, wounds and scars as a result of fights, especially during the breeding season; (ii) parasitic damage affecting the scales. This is due to the burrowing of a worm under the scales and is visible as a wavy, brown line; (iii) fraying of the edges of the scales, also caused by parasitic disease.

Damage Done During Flaying and Fleshing.—(i) Dragged scale—from dragging the animal on the belly; (ii) bad shape—resulting from inaccuracies of the ripping lines; (iii) scores, gouge marks and holes due to hard handling.

Damage Due to Exposure to Sunlight.—As stated above, the skin should never be exposed to direct sunlight.

Damage During Curing and Storage.—(i) Scale-slip; (ii) red-heat; (iii) putrefaction; (iv) over-dryness.

Grading

Grading serves to assess the value of the "belly" to the tanner. The better the quality of the leather he can make and the more he can use of the "belly", the higher the value. As crocodile leather is used mainly for luxury articles, grading is more strict than in the case of hides and skins.

Class A—Without Buttons

Primes.—Should be completely free of blemishes and faults of any sort. Must be of good shape, with no mechanical or parasitic damage; free from scale-slip, red-heat, sun scorch; must be pliable and perfectly cured.

Seconds.—May show small mechanical or chemical damage, but not at the centre. Such defects may be up to 4 in. from the edges. Badly taken off legs, tail or neck, or small parts of skin missing from any of these places.

Thirds.—Any kind of damage in the main part of the "belly". General scale-slip, red-heat or sun scorch. Whole legs, tail or neck missing.

Rejects.—Any "belly" not falling into the above three main categories, e.g. bad cuts, putrefaction, excessive sun scorch and brittleness, in fact, in such condition that the cost of freight and tanning is not justified.

Class B—Buttoned

Grade I.—Buttons on the neck only, otherwise as primes.

Grade II.—Buttons on the neck only, otherwise as seconds without buttons.

Grade III.—Buttons on the body up to three-quarters of the "belly", otherwise as primes.

Grade IV.—Buttons as in Grade III, and damage as in Thirds without buttons.

PRICES

The prices paid for skins are affected by the following factors: the presence or absence of buttons; the grade; the size.

Crocodile skins are usually bought by their width. The skin is laid flat on a concrete floor or table, care being taken that it is not stretched at all. The measurement is taken between the scales of the first, hard scutes in the widest part of the belly. (Fig. 7.) The price is paid per inch of width. However, the highest prices are always paid for "bellies" between 16 in. and 29 in. in width, which is taken as the standard price. Below or above these dimensions the price gradually decreases:—

Width in inches		*Price*
6– 9	..	⅓ of standard price.
10–11	..	½ of standard price.
12–15	..	¾ of standard price.
16–29	..	*Full standard price.*
30 and above		⅔ of standard price.

As an indication only, the price structure is shown below.

Many importers have their own system, which may differ from this in some way, but the general principle remains the same.

CLASS A—WITHOUT BUTTONS

		Price
Primes	..	100% of full price.
Seconds	..	66% of full price.
Thirds	..	50% of full price.

CLASS B—BUTTONED

The prices paid for buttoned "bellies" are usually equal to the price of thirds, i.e. 50 per cent of the price for primes.

Grade I	..	..	..	100%
Grade II	..	..	..	75%
Grade III	..	..	..	50%
Grade IV	..	..	..	30%

For example: a crocodile "belly", Class A Second, 10 in. wide, is being sold. The current price is Sh. 6 per inch. As the skin is only 10 in. wide it will fetch half the standard price, viz. Sh. 3 per inch; but because it is a Second, it will be worth only 66 per cent of the full price, that is Sh. 2 per inch. As the width is 10 in., the value of the skin is Sh. 20. However, had the skin been Prime, it would fetch Sh. 3 per inch, i.e. Sh. 30.

As seen from the above calculation, the grading of crocodile skins is rather complicated and, therefore, some buyers employ a simplified method, based more or less on judgment and experience. Needless to say, the price structure is affected by many factors, such as demand, distance from railhead or port; whether the buyer is a middleman or an exporter, and so on.

Some buyers do not buy on the width but on the length. When buying on the length, the "belly" is measured from "tip to tip" and payment is made per number of complete feet, but not for additional inches.

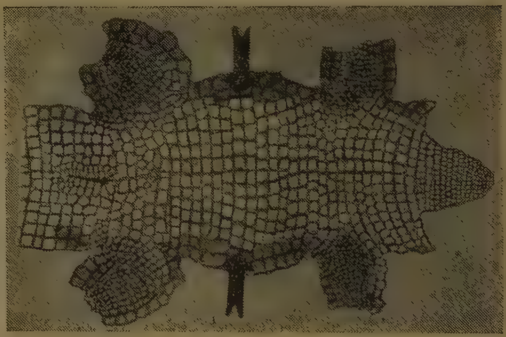

Fig. 7—How to Measure Width of Bellies.

The proportion between the body width and the length differs according to locality of origin. For instance, in crocodiles from Lake Victoria, 2.9 to 3.1 inches of belly width correspond to 1 ft. of length; the Lake Rukwa crocodiles have 2.75 inches of belly width per 1 ft. of length. In the river crocodiles, the proportion is 2.5 in. of width per 1 ft. of length.

Crocodile skins as long as 17 ft. have been exported from East Africa. The greatest width of belly among export batches does not usually exceed 50 in.

BY-PRODUCTS

It is regrettable that a part of the skin only is used, the remainder of the crocodile being entirely wasted. Bone and meat meal could be manufactured from crocodile carcasses. The average yield would be approximately one-third of the total weight of the carcass, so a 1,000 lb. crocodile would yield 320–350 lb. of bone and meat meal. The oil could be used in tanneries for fat-liquoring of leather; the meat and bone meal would be a valuable stock feed. The crocodile tail contains a special oil which is used as a fixative in the perfume industry. The horny scutes from the back yield a good quality glue. Taking into consideration that the average weight of a crocodile, caught at Lake Rukwa, is approximately 1,000 lb., one can realize that though every skin exported represents an income, there is a tremendous wastage involved. It is strongly urged that local co-operatives or companies employed in large-scale crocodile hunting should establish plants for the manuafacture of by-products. This would not only produce a very substantial income, but would also create new employment and supply valuable protein, lime and phosphate for the indigenous livestock. Such factories could be mobile or placed on barges similar to those operating on whalers, where all portions of the whale are utilized. Tests carried out at the Veterinary Research Laboratory, Kabete, have proved that crocodile meal when used as poultry and pig feed is not inferior to that derived from domestic animals or fish.

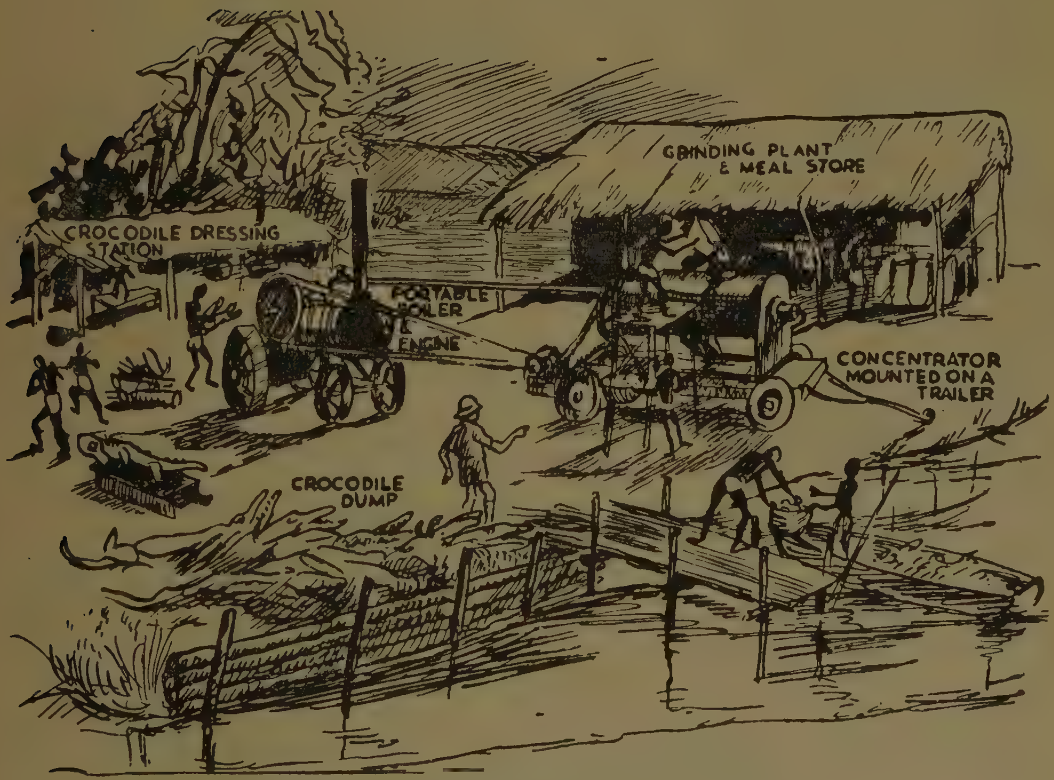
CROCODILE DRESSING STATION
PORTABLE BOILER & ENGINE
GRINDING PLANT & MEAL STORE
CONCENTRATOR MOUNTED ON A TRAILER
CROCODILE DUMP

Fig. 8—Sketch of Crocodile By-products Plant.

RELATIVE VALUES OF FEEDING-STUFFS

By M. H. French and H. P. Ledger, Joint Animal Industry Division of E.A.A.F.R.O. and E.A.V.R.O.

(*Received for publication on 28th June,* 1953)

Much has been said and written in recent years of the need to make the maximum use of home-grown feeding-stuffs and to reduce to a minimum the quantities of concentrated foods purchased from outside the farm. This is sound advice but, for certain classes of livestock, certain forms of animal production, and under certain systems of livestock management, the purchase of animal foods may be essential if maximum economic output is to be achieved. Under such circumstances, farmers naturally desire to know what are the most economic foods for their particular purposes.

There are insufficient quantities of a number of concentrate feeding-stuffs to meet the needs of the livestock industry, or the supply of them may be so seasonal that shortages occur periodically and locally. Under such conditions farmers desire to know the possibilities of replacing those in deficient supply by others of equivalent feeding values and costs. From the point of view of the overall efficiency of the livestock industry, the best use should be made of existing feeding stuffs and those in short supply should not be used in the wrong way and their particular virtues wasted or utilized inefficiently and expensively.

The table accompanying this article gives the costs of a number of foodstuffs, together with their feeding values in terms of digestible protein and starch equivalents. These feeding values were determined with East African foods in digestibility trials with East African animals under local conditions. They may therefore differ slightly from figures published overseas concerning similar foodstuffs, grown under different soil and climatic conditions and determined by experiments on European breeds of livestock.

The foodstuffs mentioned in the table have been grouped into roughly comparable categories and any food in a given category can be replaced by another in the same group with such minor arithmetic adjustments as are necessary to bring their feeding values as nearly into agreement as possible. For instance, maize could be replaced by millet on the basis of nutritive values but it would be wasteful of protein to replace the maize with groundnut cake.

It is evident, from a study of market values, that total price (per ton or bag) does not necessarily indicate the value of a given foodstuff to an individual farmer. The market prices prices fluctuate with season and locality so that it is impossible to publish tables showing the permanent relationship between the prices of different foods for feeding livestock. All that can be done is to show how the relative costs of the feeding-stuffs can be calculated and to indicate their actual relationships on a given day and in a given place.

The cost of purchased food to a farmer may not only be its market price because to the latter must be added all transport charges until the food is delivered on the farm. Foods differ considerably in digestibility and in their contents of digestible protein and their starch equivalent (fat or energy-producing) values. Since the farmer buys feeding-stuffs for their nutrient contents the only way to compare different foods is to determine the price value of their digestible protein or starch equivalent contents. This can be done in two ways and, for brevity, the formula for calculating the cost of digestible protein (D.P.) will be given, although starch equivalent costs would be determined in exactly the same way. In this context, cost means purchasing price plus all transport charges to the farm.

$$\text{Cost of a unit of D.P.} = \frac{\text{Cost per ton}}{\text{D.P. }\%}$$

$$\text{Cost of 1 lb. of D.P.} = \frac{\text{Cost per ton}}{22.4 \times \text{D.P. }\%}$$

When purchased concentrates are brought on to a farm, a large percentage of the nitrogen and mineral contents may be used for building up soil fertility through the fertilizing effects of the dung dropped on the land or of the farmyard manure applied to the fields. In certain overseas countries, an allowance for this manurial value is deducted from the cost of feeding-stuffs before calculating the cost of a unit (22.4 lb.) or 1 lb. of digestible protein or starch equivalent. No such deduction for manurial value has been made in the costs quoted in the table because it is not yet known what factors for calculating manurial values should be employed under the wide variety of soil and climatic conditions encountered in East Africa.

FOOD	Av. wt. per bag	Price per bag	Cost* per ton	Digestible Protein	Starch Equivalent	COST PER UNIT		COST PER LB.	
						Digestible Protein	Starch Equivalent	Digestible Protein	Starch Equivalent
	lb.	*Sh. cts.*	*Sh.*			*Sh. cts.*	*Sh. cts.*	*Sh. cts.*	*Sh. cts.*
CEREAL BY-PRODUCTS									
Pollards	150	18 35	274	12	56	22 83	4 89	1 02	0 22
Wheat Bran (Broad) ..	50	8 60	385	11	43	35 00	8 95	1 56	0 40
Wheat Bran (Fine) ..	100	11 65	261	10	50	26 10	5 22	1 16	0 23
TUBERS									
Dried Cassava	160	36 50	511	1	85	11 00	6 01	22 81	0 27
ANIMAL PROTEIN									
Blood Meal	224	125 00	1,250	60	60	20 83	20 83	0 93	0 93
Meat Meal	160	89 00	1,246	45	70	27 69	17 80	1 27	0 79
LEGUME FODDERS									
Lucerne Hay	90 (bale)	11 50	285	11	32	25 91	8 91	1 16	0 40
Lucerne Meal	100	19 00	425	12	35	35 41	12 14	1 58	0 54
CEREALS									
Barley	180	35 50	442	9	72	49 11	6 38	2 19	0 27
Barley (crushed) ..	150	34 50	515	9	72	57 22	7 15	2 55	0 32
Barley (meal)	180	39 00	485	9	72	53 88	6 72	2 40	0 30
Maize (white)	200	49 15	550	8	80	68 75	6 87	3 06	0 31
Maize (meal)	200	53 45	598	8	80	74 75	7 47	3 34	0 33
Millet, bulrush, Mawele	200	42 10	471	9	72	52 33	6 54	2 34	0 29
Millet, white Mtama ..	200	40 00	448	8	76	56 00	5 89	2 50	0 26
Oats	150	35 65	532	9	60	59 11	8 86	2 64	0 39
Oats (crushed)	100	26 00	582	9	60	64 66	9 70	2 89	0 43
Wheat (rejected) ..	190	35 00	412	9	75	45 77	5 49	2 04	0 24
Wimbi (Eleusine) ..	200	54 00	605	9	75	60 72	8 07	3 01	0 36
OILSEEDS AND OILSEED RESIDUES									
Cottonseed	150	23 10	300	13	80	16 67	3 75	0 10	0 17
Sunflower Seed	100	60 00	1,210	13	104	93 08	11 63	4 15	0 52
Cottonseed Cake ..	185	40 00	484	23	75	21 04	6 45	0 94	0 29
Coco-nut Cake (copra) ..	180	46 00	572	17	75	33 65	7 63	1 50	0 34
Groundnut Cake ..	180	44 30	551	38	80	14 50	6 88	0 65	0 31
Linseed Cake	185	65 75	796	26	75	30 61	10 61	1 37	0 47
LEGUME SEEDS									
Beans:									
C.W. Type	200	58 50	655	18	75	36 38	8 73	1 62	0 39
Haricot..	200	58 50	655	18	75	36 38	8 73	1 62	0 39
Njahi	200	64 00	717	18	75	39 83	9 56	1 78	0 43
Cowpeas	200	54 00	605	21	80	28 81	7 56	1 29	0 34
Field Peas	200	58 50	655	21	80	31 19	8 19	1 39	0 37
Pigeon Peas	200	58 50	655	21	80	31 19	8 19	1 39	0 37

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*When compiling this table, prices were chosen which were in line with those quoted in Nairobi in December, 1953. Prices vary from season to season and from one district to another and the figures used are not intended to indicate the prices which should apply at any given point in time or locality. They are quoted only for illustrative purposes and, when making purchases, farmers should make their own calculations on the lines indicated in the text.

THE CHEMICAL COMPOSITION OF THREE "WEEDS" IN THE KENYA HIGHLANDS

By H. W. Dougall, Department of Agriculture, Kenya

(*Received for publication on* 18*th November*, 1953)

The need for a wider knowledge of the composition of grasses, clovers, herbs and weeds, so frequently expressed in the United Kingdom, is no less desirable in Kenya. Boyd-Orr [1] in Scotland, Fagan [2, 3, 4] in Wales, and Brynmor Thomas [5, 6, 7, 8, 9, 10] in the North of England, with their colleagues, have contributed substantially to the present state of knowledge at home, but for East Africa, apart from the work of French [11], similar data is generally lacking.

The purpose of this paper is to discuss briefly the composition of three alleged "weeds", and to show that two of them at least are not without some value to livestock. The first, spurrey (*Spergula arvensis*), is of widespread occurrence on newly broken arable land and in newly sown leys; the second, plantain (*Plantago lanceolata*), occurs fortuitously in sown leys, and Percival [12] states that it spreads as a result of its seed occurring with the seed of Perennial and Italian rye grass; the third, campion (*Silene gallica L.*) is said by Bogdan [13] to occur frequently and become troublesome in the Eldoret region and, to a less extent, in the Njoro–Nakuru region.

A glance at Table 1 shows that the three "weeds" are rich in protein and low in fibre. Each has a high ash content and is very well supplied with phosphoric oxide (P_2O_5) and lime (CaO).

Spurrey has no place in British agriculture and no data other than the composition of its seed [14] are available to the writer. From Holland, on the other hand, van den Eynden [15] reports that 20,000 acres are grown there annually as a second crop after rye, and that spurrey is cultivated also in Poland, Germany and Spain. He tells us that in 6–8 weeks a crop for cutting or for grazing within an electric fence can be obtained, and that good quality is imparted both to milk and butter. He regards early flowering and seed-shedding as disadvantages of the plant; and acknowledges the danger that it might become a weed of subsequent tillage crops. From the mineral aspect, the value for P_2O_5 given by van den Eynden is very similar to our Kenya figures, but CaO is higher in the Holland analysis. On the other hand, a value of five per cent for digestible protein, given by van den Eynden in his communication, probably might be exceeded in Kenya. Bosch and Deijs [16] in Holland, showed the digestibility of protein in spurrey to vary between 71 and 58 per cent, and if we assume arbitrarily that only one-third of the 27 and 30 per cent crude protein found in Kenya samples is digested, values will still be higher than that given by van den Eynden.

COMPOSITION OF SPURREY, PLANTAIN AND CAMPION
(*Per cent of Dry Matter*)

PLANTS	SPURREY			PLANTAIN		CAMPION
Place	S. Kinangop	Molo	Holland	Elburgon	N. England	Molo
Altitude	8,300 ft.	9,000 ft.	sea level	7,600 ft.	sea level	9,000 ft.
Total Ash*	17·29	19·14	—	12·19	—	25·75
Crude Protein	27·50	30·32	—	21·01	—	22·48
Ether Extract	7·69	1·92	—	—	—	2·05
Crude Fibre	13·46	14·14	—	—	—	11·25
Carbohydrate	34·06	34·48	—	—	—	38·47
*Including—						
Phosphoric oxide (P_2O_5)	1·08	0·88	1·01	0·88	0·75	0·58
Lime (CaO)	0·77	0·85	1·32	1·56	2·32	1·81

For plantain, values obtained for the major mineral constituents compare very favourably with those obtained by Thomas *et al.* [10] in the North of England. Fagan [2] remarked on the high protein and low fibre content of this plant and he and Watkins [4] regarded it as an excellent source of calcium and a good source of phosphorus, findings which accord fully with results in Kenya. Elliott [17] thought so highly of plantain that he included it in seeds mixtures, and Milton [18] demonstrated that its capacity for dry matter production could be greater than that of rye grass.

Campion as a fodder plant is an unknown quantity so far as the writer is aware, but as judged on chemical analysis, its composition is very good, especially from the standpoint of protein and of calcium.

SUMMARY

The composition of campion is good, but it is an unknown quantity from the viewpoint of animal fodder.

Analyses of "Kenya" plantain and spurrey compare very favourably with results reported from England and from Holland respectively. In light of the value placed upon these plants in their respective roles in these two countries, it is suggested that their presence in Kenya pastures should cause no excessive concern.

REFERENCES

[1] J. B. Orr.—Minerals in Pastures. Lewis & Co., London (1929).

[2] T. W. Fagan.—Agric. Progress (1931), *8*.

[3] T. W. Fagan and W. E. J. Milton.—*Welsh J. Agric.* (1931), *7*.

[4] T. W. Fagan and H. T. Watkins.—*Welsh J. Agric.* (1932), *8*.

[5] B. Thomas, J. R. Escritt and N. Trinder.—*Emp. J. Expt. Agric.* (1945), *13*.

[6] B. Thomas and N. Trinder.—*Emp. J. Expt. Agric.* (1947), *15*.

[7] B. Thomas and A. Thomson.—*Emp. J. Expt. Agric.* (1948), *16*.

[8] B. Thomas.—Scottish Agriculture (1949), *29*.

[9] B. Thomas and A. Rogerson.—Scottish Agriculture (1950–51), *30*.

[10] B. Thomas, A. Thomson, V. A. Oyenuga and R. H. Armstrong.—*Emp. J. Expt. Agric.* (1952), *20*.

[11] M. H. French.—*E.A. Agric. J.*, Jan. (1943).

[12] J. Percival.—Agricultural Botany. Duckworth, London (1949).

[13] A. V. Bogdan.—*E.A. Agric. J.* (1950), *15*.

[14] H. E. Woodman.—Bull. 124. Ministry of Agriculture, London (1947).

[15] C. P. A. van den Eynden.—Private Communication, Nov. (1953).

[16] S. Bosch and W. B. Deijs (Netherland's Publication).

[17] R. H. Elliott.—The Clifton Park System of Farming. Faber & Faber, London (1942).

[18] W. E. J. Milton.—*Welsh J. Agric.* (1938), *14*.

TREE-PLANTING IN TANGANYIKA

III. Species for Dry Areas

By M. S. Parry, Forest Department, Tanganyika

A previous article described species suitable for planting in the Highlands. The present article deals with those recommended for planting in the extensive dry zone, which is taken to include land between 2,500 ft. and 4,000 ft. altitude, having an annual rainfall less than about 35 inches. Most of the species described will grow equally well or better in the coastal belt, and are also suitable for the wetter *miombo* country such as Geita, Kigoma or Mpanda where the rainfall is about 40 inches. These latter areas are, however, now proving suitable for some of the species usually planted in the Highlands, especially Pines and Eucalyptus.

Areas having less than 25 inches of rainfall are in general most unsuitable for tree-planting, though something can usually be done with the dry *Acacias, Cassia,* Figs and, of course, "Manyara" (*Euphorbia tirucalli*) and Sisal.

Acacia arabica

An exotic species which has been planted as an avenue tree, and also for fuel, in parts of the Lake Province. Isolated trees have large dense, spreading crowns and a short bole. It makes a very good shade tree in dry cattle country, and the pods are a useful fodder. If grown at a close spacing in plantations, it has a more erect habit but, even so, poles tend to be rather crooked. The timber is hard and durable and is used for railway sleepers, etc., in the Sudan. Although planted mainly in dry country it really needs a deep alluvial soil, and will grow well only on the lower slopes in heavy soil (but not on the worst types of cracking *mbuga*). It will survive on the lighter soils higher up the slope, but only does well there near seepage lines or on deep soil. It can be established fairly easily by direct sowing. The seed needs to be plunged into boiling water and soaked overnight before sowing. It grows at the rate of about 2 ft. per annum and in Sukumaland attains a maximum height of about 25 ft. It will not coppice but sparse natural regeneration occurs under plantations. It is not attacked by termites, nor browsed by stock.

Occasional trees develop an erect fastigiate habit which is preferable to the normal spreading form in plantations, but it is not possible at present to obtain seed which will breed true to this variety.

Acacia campylacantha

A common indigenous tree occurring mainly along water courses in dry country or on moist, long-grass, alluvial soils on the eastern foothills of mountain ranges. It is believed to be botanically very near to *Acacia catechu*, a well-known Indian tree, which yields a fuel of high calorific value, and also "cutch", a substance of commercial importance used in dyeing and tanning. *A. campylacantha* has been planted on a small scale in Sukumaland, but the plantations are still immature.

It is easy to establish on all soil types by direct sowing. The seeds need no pre-treatment. It is probable that on dry sites it will die back after a few years, but it shows promise of growing well on *mbuga* or at least on the margins of *mbuga* soils. The rate of growth is rapid, averaging about 3–4 ft. per annum on heavy soils.

One drawback to its use as a fuel species is the fact that it bears exceptionally large hooked thorns which persist even on the main branches and make the tree unpleasant to handle. Occasional trees are thornless, when mature, but pure breeding seed of this variety (if it is a variety and not a response to local conditions) is not available.

Acacia senegal (Gum Arabic)

A medium-sized indigenous tree which occurs throughout the drier parts of Tanganyika. It yields the true "gum arabic" of commerce, and is tapped for this product in Sudan and West Africa. In Tanganyika, trees have shown very little response to tapping, and most of the gum collected in Shinyanga District comes from species of gall-Acacia, chiefly *A. drepanolobium.*

The chief interest of *A. senegal* is its ability to grow on poor sandy or stony soil, and on the Sukumaland "hardpan" soils. It has, in fact, been used to fill up failed patches in *Cassia* plantations. It is easy to establish on sandy soils by direct sowing untreated seed and grows at the rate of 2–3 ft. per annum. The tree has a straggly form when young but after 15–20 years develops into a reasonably straight-boled tree 20–25 ft. high. Mature trees produce abundant regeneration, and will form dense thickets of young trees around themselves if grass is kept down by grazing.

Acacia spp.

There are several other indigenous *Acacias* which have not yet been used for plantations, but which can be recommended for trial in very dry areas. They could probably all be established by direct sowing. The following are the more interesting species.

A. albida.—A very large tree which grows only on deep alluvial soil or along water courses. It produces great quantities of large curled pods resembling "apple rings" which are a valuable fodder. A group of these trees, familiar to many people, is growing near the Morogoro Club.

A. pallens (Knobthorn).—A straight-boled tree bearing conspicuous "bosses" on the trunk. The timber is durable and has been used for railway sleepers. Would reach timber sizes only on deep soils with a rainfall exceeding 30 inches.

A. rovumæ.—A large, flat-crowned tree with a spirally fluted bole. A few large specimens occur in Dodoma Township. The timber is very hard, durable and blood-red in colour. Does not seed very profusely.

A. spirocarpa.—The best-known flat-topped *Acacia* which dominates the "Parkland" country of Masailand and the Serengeti National Park. Occurs also in the Dodoma thorn-bush and in East Sukumaland where it forms a fairly close-canopied woodland. It has not been used for afforestation, but in over-grazed areas, where there are sufficient large trees to provide seed, it frequently forms dense thickets of regeneration which, though a nuisance from the grazing point of view, indicate the possibilities of this species as a fuel supply in very dry areas. It appears to prefer a fertile, calcareous or volcanic soil. It has an attractive shape and appearance when mature and the pods are a useful fodder.

Agave sisalana (Sisal)

Mention of the common cultivated sisal may seem out of place in an article on tree-planting, but in dry country, especially in Sukumaland, sisal is of great value as a substitute for the more usual forest produce. It forms an almost impenetrable cattle-proof hedge when closely planted, and is a useful means of demarcating boundaries around forest or grazing reserves, woodlots, etc. The wild Aloe is also used for this purpose. The pole on which the inflorescence is borne is very straight and light and is ideal for roofing. It is fairly durable, especially when cured by wood smoke in a native hut.

Sisal can be conveniently propagated by transplanting the small suckers which occur around the base of the mature plant. Transplanting is very easy and usually successful even if only a small amount of root is left attached.

Afzelia quanzensis: Mkora (Swa., etc.)

A valuable indigenous timber tree which occurs in a variety of habitats—coastal forest, *miombo*, and even in the dry-thicket areas, and kopjes of the Lake Province. The timber is hard, heavy, durable and red in colour, but fairly easy to work. No plantation data is available, but the tree is fairly easy to establish either direct from the large "lucky bean" seed or preferably by means of stumps. Like many indigenous dry-forest species the seedlings are liable to check for a few years after planting. The foliage is a pleasing dark shining green, and the tree is excellent as an ornamental shade tree around *barazas*, etc., though much slower growing than most exotics.

Albizzia lebbek

An exotic species commonly planted as an ornamental tree in dry areas. The foliage is dark green and the flowers white, sweet-scented and showy. It is fairly easy to establish by direct sowing, and is suitable as a plantation species for fuel and poles, though in this respect *Cassia siamea* is usually found to be easier to sow and equally useful, as well as being slightly faster growing in most places.

Azadirachta indica (Neem)

A well-known species planted extensively in dry areas in India, Sudan, West Africa and elsewhere. It has not been planted in Tanganyika, apart from a few ornamental trees at the coast, largely owing to the difficulty of obtaining viable seed, but it should certainly be suitable for planting in areas of 30 in.–35 in. rainfall or even less.

In India the durable heartwood is used for many purposes, including house-building and furniture.

Seed is not easy to obtain in East Africa, but small amounts can be collected from odd trees (e.g. in Tanga and the Dar es Salaam Botanic Gardens). The seed rapidly loses its power to germinate and must be sown fresh. It is usually established by direct sowing, but with a limited amount of seed it would be more profitable to use large nursery transplants or potted stock. It needs about a year in the nursery.

Callitris robusta and C. calcarata

These species, like the more drought-resistant Cypresses which they resemble, should also be suitable for planting on good soils in fairly dry country (30 in.–35 in. rainfall), but would be more likely to do well at temperate altitudes. *C. robusta* is reputed to be hardier than *C. calcarata*, and is recommended as a low shelter-belt tree in dry areas in South Africa. The timber is straight-grained, fairly hard and durable. Poles from thinning are said to be termite-resistant.

They can be raised and planted from boxes or pots like Cypress, but are much more difficult to transplant and should never be planted with bare roots.

Cassia siamea

A medium-sized exotic tree, which is easily the most popular species in Tanganyika for afforestation in dry or coastal regions, where it flourishes with surprising vigour. Its merit lies in the fact that it is easy to establish, fast-growing, drought-resistant, tolerant of many soil types, completely resistant to termites even when young, and coppices readily. The poles are usually straight, especially from coppice shoots, but are not very durable unless they are large enough to contain a fair proportion of heartwood. The tree rarely attains timber sizes, but a few old trees have been used for baulks in various places. It is a useful industrial fuel species, but the wood burns rather too rapidly for it to be considered ideal for domestic use, though it is commonly used for this purpose.

In Tanganyika it is almost invariably planted by direct sowing, as the seed germinates readily without pre-treatment and is obtainable in large quantities. The seed costs about 10 cents a pound to collect, and is commonly sown at the rate of 1–2 lb. per acre. In dry country undoubtedly the most satisfactory planting technique is to sow the seed in lines along tied-ridges. If the ridges are spaced 4 ft. apart and labour is available cotton or some other crop and *Cassia* can be sown on alternate ridges. In moister areas, with a porous soil, tie-ridging is unnecessary, but it is best to make small ridges 8 ft. apart in order to locate the lines of seedlings. Planting with crops is again the most satisfactory procedure. It can also be planted, in sandy soils, by means of stumps, the shoots from which grow more rapidly than seedlings.

Cassia grows rapidly from seed, usually reaching 4–6 ft. in the first year. It reaches pole sizes in 10–15 years according to site, but requires a much shorter period when regenerating from coppice in the second rotation.

In moist areas, *Cassia* normally prefers a light soil, as it will not stand waterlogging. In dry country, however, it frequently does best on heavier soils such as riverside alluvium or marginal *mbugas*, though it will also grow well on light sands, provided they are deep or fed by seepage water. On heavy soils the seed tends to get covered with mud and does not germinate very readily nor will stumps strike so easily. It will survive on shallow soils and even on the Lake Province impervious "hardpans", but in these situations growth is irregular and the tree commonly fails in patches or "sticks" at a height of about 15 ft.

Yields from average quality plantations run to about 2,000–2,500 cu. ft. per acre of fuel, excluding small branchwood. This is obtained after about 10–15 years from seed or after 5–7 years from coppice. Under ideal conditions the tree attains a height of about 45 ft. on short rotations and would probably produce at least 3,000 cu. ft. per acre on a seven-year coppice rotation. Plantations on the very dry Sukumaland "hardpan" soils rarely exceed more than 20 ft. height and yield a total of about 1,500 cu. ft. per acre (of which a third is small branchwood) after 15 years from seed. The same yield would be obtained in about seven years from coppice.

Plantations which are being managed for fuel or poles should be thinned after one year's growth from seed to the usual spacing of about 8 ft. × 8 ft. (or closer on good sites if only small produce is required). Thereafter no thinnings should be removed as coppice shoots from the cut stumps will be suppressed by the remaining trees. It is preferable to wait until the trees have reached the desired size, and then to clear-fell the whole plantation. All the stumps will then produce masses of coppice shoots which should require no weeding. Coppice is usually sufficiently vigorous to withstand even intensive grazing. Some of the outer shoots may be nibbled but the central ones will get through. The season of felling makes very little difference to the vigour of the coppice. After one year (or longer if there is a demand for larger withies) the coppice shoots should be thinned to about two per stump.

Cassia has an ornamental yellow flower and remains in flower for long periods. It does not lose its leaves or only slightly during the dry season and is therefore a useful avenue tree, but it is too common to be much appreciated as an ornamental.

A serious disease caused by a root fungus (*Polyporus* sp.) has occurred in *Cassia* at Ngudu growing on dry shallow granitic sand. Many trees in the Station and adjoining fuel plantations have been killed, but the disease so far has not spread to other localities.

Cupressus spp.

It would be premature to recommend any species of Cypress for plantation work in the drier parts of Tanganyika, as they have not yet been tried on an adequate scale or for a long enough period, but on the basis of South African experience and observations on a few ornamental trees, it seems probable that the more drought-resistant species would survive on good soils in the 30 in. rainfall regions. The species most likely to be suitable are *C. arizonica, C. torulosa* and *C. sempervirens*. These may be expected to grow at the rate of about 2 ft. per annum during the early years. These species can be recommended as ornamental trees in gardens, but in very dry areas the foliage is likely to be straggly. *C. arizonica* is growing well in gardens at Morogoro, and would also be suitable for plantations in temperate areas considered too dry for *C. lusitanica*.

Dalbergia sissoo (Shisham or Sissoo)

A very common tree in India where it occurs mainly in alluvial tracts and is planted extensively in dry areas usually in irrigated plantations. It survives in very dry situations but not on clay soils. The timber is attractive, hard, strong and durable, used for a great variety of purposes.

In Tanganyika the only recorded plantation is at Ngudu (30-in. rainfall, 4,000 ft.), where it has attained a height of about 25 ft. in 15 years on a very dry, shallow granitic sand. These trees are not outstanding and are inferior to neighbouring *Cassia*, but the tree is worth trying elsewhere under less severe conditions.

The Ngudu trees seed prolifically. The tree is commonly raised by direct sowing, but for small-scale trials, potted plants would be preferable in dry areas. It can also be planted from stumps or root suckers. Sissoo is reputed to be very susceptible to weed competition and needs to be kept clean until established.

Delonix elata (Wild Flamboyant)

An indigenous tree of dry thicket resembling and closely related to the common ornamental Flamboyant except that the flowers are yellow. It is common around Dodoma. It is used as a fencing material by natives, who strike it from large cuttings, but it is not particularly suited to this purpose as it soon grows up and gets gappy beneath. The foliage and flowers are quite ornamental but the tree is leafless in the dry season.

Delonix regia (Flamboyant)

A well-known ornamental tree growing in most townships in Tanganyika. It produces a brilliant display of scarlet flowers for a few weeks in November–December. Its chief drawback as an ornamental tree is the fact that it remains leafless for some months in the dry season. It is best planted for ornamental use by means of large potted transplants, but will also grow from stumps. The seed is large and the seedling grows fast in the nursery, needing only about four months, from sowing to planting, or eight months in the case of stump-planting.

Eucalyptus spp.

There are many species of Eucalyptus capable of growing in dry areas with a rainfall of 25 in.–35 in. Unfortunately young seedlings of nearly all species are very liable to be attacked by termites. It has been found that damage to very young trees can be greatly reduced by applying gammexane at the rate of ½ oz. per plant to the soil around the roots when the trees are planted (*see* note under Eucalyptus for Mountain Areas). *Eucalyptus* species should, however, normally be planted only where termites are not very numerous, such as on heavy soils, riverside alluvium, or in seepage areas below dams. Termite damage appears to be correlated with drought damage, the one aggravating the other. Termites may attack living trees largely to obtain moisture. The damage from both causes can be alleviated by using weeds, etc., to form a green surface mulch between the rows of trees.

On heavy soils, e.g. *mbugas* in Sukumaland *E. microtheca* has done well. It is a rather crooked tree, but is useful for fuel or rough poles. It has reached a height of 30 ft. in about 12 years and would no doubt grow faster and straighter from coppice. The microscopic seed requires careful sowing in finely sifted soil, and should be watered with a very fine spray. It would probably not survive in the worst type of *mbuga*, which cracks, and therefore dries out, to a depth of two or three feet.

On moist riverside alluvium or in seepage areas, provided the latter are not stagnant, *E. citriodora* and *E. saligna* can be recommended as a source of fast-growing, straight poles. *E. citriodora* is fairly drought-resistant and at Ngudu (30 in. rain at 4,000 ft.) a small plot is growing fairly well on an extremely unfavourable "hardpan" soil. None of the drought-resistant species has yet been planted extensively in the dry areas of Tanganyika but the species most likely to succeed, assuming termite-damage is not serious, are: *E. camaldulensis* (= *E. rostrata*), *E. cladocalyx*, *E. melliodora*, *E. microtheca*, *E. paniculata*, *E. racemosa* (= *E. crebra*), *E. tereticornis*, *E. sideroxylon*.

Near Malya in Sukumaland (rainfall 25 in.–30 in., altitude 4,000 ft.) small experimental plots of several gums were planted in the exceptional drought year of 1949 on a fairly deep, red ironstone loam. Of the species tried, the most promising are *E. camaldulensis*, *E. cladocalyx*, *E. citriodora* and *E. sideroxylon*, which grew to 20–25 ft. in 2–3 years. Also promising but less outstanding were *E. tereticornis*, *E. racemosa*, *E. paniculata* and *E. microtheca*.

Of the species mentioned, *E. citriodora*, *E. paniculata* and *E. sideroxylon* would give the straightest poles, while *E. camaldulensis* would probably have the greatest yield of fuel. *E. camaldulensis* is also renowned for its ability to withstand waterlogging and should grow well in slightly swampy places in dry country. It is, however, not a particularly straight-growing tree.

Euphorbia tirucalli (Manyara)

This is the succulent plant widely used by natives in the Central Province and Sukumaland as a hedge plant around their huts and compounds. Though universally disliked and commonly regarded as the last resort of the tree planter in dry country, the Manyara has a great deal to recommend it. It will survive in the very driest country, where its fresh green appearance is a refreshing change amidst the general barren monotony. It is commonly grown as a hedge 6–8 ft. high, but will get up to about 20 ft. if left alone, and will then provide a certain amount of fuel, plus a vast amount of new planting material.

It is always planted by sticking branches firmly into the ground. This should be done in dry weather before the rains break. The small green "twigs" are left attached to the cuttings and in this way a solid hedge 2–3 ft. high can be created immediately. In a year or two the hedge will be 6–8 ft. high. Manyara cuttings are unpleasant to handle as the white latex causes extreme irritation if it gets into the eyes. Manyara will survive most things, but is killed by fire and may also be nibbled back by starving cattle.

The only really serious objection to Manyara is that it is alleged to harbour rats and mice which burrow around the roots. In the Lake Province especially this results in the loss of a great deal of food, but possibly the problem could be dealt with by less drastic measures than the extermination of Manyara. It would be difficult to suggest an alternative species suitable for forming solid hedges or low windbreaks in barren, open country.

Ficus spp. (Wild Figs)

Most of the very big trees seen in dry country are species of wild figs. Many of them start as epiphytes on another tree which is slowly smothered. The fig finally kills its host and takes its place. The wild figs have no great value other than as shade trees, for which purpose they may be worth planting around native courts, schools, etc. It is unwise to plant them too close to a building (or to put a building too close to a fig) owing to the mess caused at certain seasons by rotting fruits. Figs are usually planted by striking large cuttings planted like posts 6–8 ft. long a month or two before the rains.

Gmelina arborea

An exotic small timber species related to teak, which has not yet been tried adequately, but which is expected to prove suitable for planting in the 30 in.–35 in. rainfall regions. The seed is contained in hard fruits, which average about 200 to the pound and can be sown direct in areas of fairly high rainfall. In drier localities it is preferable to plant with "stumps" or pots. The seedlings grow rapidly, requiring about 4–5 months in the nursery to reach a height suitable for stumping.

Jacaranda mimosæfolia

An ornamental tree, with a graceful foliage and very beautiful mauve flowers which are produced in large quantities for a few weeks early in the rains. The timber is reputed to be useful for tool handles, etc. For ornamental purposes planting is best done with transplants raised in pots or trays. The tree is fairly easy to establish. It requires about 5–6 months in the nursery. Young trees tend to grow rather spindly, and it is therefore usual to pollard the trees at a height of about 6 ft. in order to stimulate the growth of a denser crown. (A height of 15 ft. is more suitable for street planting to allow adequate clearance to vehicles.) Although best suited to moist lowland conditions (e.g. Morogoro), *Jacaranda* will survive under very dry, desiccating conditions, and is growing almost as well as *Cassia* on shallow granite sands in Sukumaland. It also does well at medium elevations in the temperate zones (e.g. Lushoto).

Mangifera indica (Mango)

A well-known tree with a large dense-foliaged crown, growing extensively in the coastal belt and in cultivated land up-country. It also occurs in the lower temperate and tropical rain forest regions. A few trees occur in favoured localities in very dry country where, however, they are usually small and produce little fruit. The Mango is usually regarded as a fruit tree, but it has also considerable amenity value as a shade tree or windbreak in dry country. The timber is hard and useful for rough work, and makes a good charcoal.

For ornamental use the Mango is best planted by means of large potted transplants, but it can also be raised by direct sowing. The fruit is large and easy to collect, but a special effort is required to obtain viable kernels by removing the edible outer pulp. If dried fruits are picked up off the ground they are likely to be rotten inside. There are several varieties of fruit and the seed cannot be relied upon to breed true. If a particular variety is required for planting it is advisable to propagate it by cuttings, layering or grafting.

Melia azedarach (Persian Lilac)

A small ornamental tree commonly planted in dry localities. It produces attractive mauve flowers which have a pleasant scent. The masses of yellow fruits are also decorative. The tree has a rather thin, straggly shape, and is of little value save as a source of small poles or stakes. In India and South Africa it often reaches a fair size, but in Tanganyika it is rarely seen as anything more than a large bush.

Moringa pterygosperma (Horse-radish Tree)

A small ornamental tree, with strongly scented white flowers and an attractive foliage. It survives under very dry conditions, but is more suited to moister localities. The tree is easy to establish by stumps or transplants and, with a good rainfall, should grow direct from seed. It is very fast-growing when young. The unripe pods can be eaten as a vegetable and the roots are said to be an inferior substitute for horse-radish.

Pinus spp.

The notes given above under *Cupressus* spp. apply also to species of pines. Assuming that mycorrhizal inoculation could be carried out effectively it is probable that several drought-resistant species would survive in the 30 in.–35 in. rainfall regions, but trials have only recently been started and it is too early to anticipate results. The species considered most suitable for trial include *P. canariensis* which has proved easy to establish by means of transplants in balls of earth, *P. halepensis* on soils which are not too acid and, possibly, *P. longifolia.*

In the moister types of *miombo* woodland in Northern Rhodesia and at Mpanda and Geita in Tanganyika, with a rainfall of 40–45 in., species such as *P. patula, P. radiata, P. caribæa* and *P. tæda* are being raised fairly successfully on moist sites, but the cost is very high owing to the necessity for weeding out dense grass growth for several years.

Prosopis chilensis (Mesquite)

A thorny shrub or small tree, native to America, which ought to be of value in dry places as a source of small fuel. The fruit pods are valuable cattle fodder. The only recorded trees in Tanganyika are at Ngudu and are very disappointing, being small, bushy shrubs after 15 years' growth. It is probable that the Ngudu trees are a poor variety, and it is proposed to introduce better forms for trial in dry cattle country.

Pterocarpus angolensis (Mninga)

This species, after Mvule, is about the second best timber in the country and is one of the most abundant and widespread. It occurs typically as a small or medium-sized tree scattered throughout the dry *miombo* woodland which covers so much of Tanganyika. Mature trees usually average about 5 or 6 ft. in girth, occasionally up to 13 ft. with bole length rarely exceeding 20 ft. except on deep accumulated soils in moister conditions.

The timber is handsome, durable, easy to work and very stable, and is widely used for furniture and a wide range of other work from plywood to ship-building. Small trees tend to contain a large proportion of pale-coloured sap-wood which, apart from being unsightly if incorporated into furniture, is very liable to become riddled with borers.

The necessity for the more intensive tending of the natural stands or further concentration of production in artificial plantations now appears advisable. Where there is a considerable demand for fuel and poles, e.g. by railways or mines, improvement fellings in favour of Mninga are economically feasible. A certain amount of investigation into the artificial raising of Mninga, as well as an examination of the seeding and establishment of natural seedlings, has been carried out.

The circular winged fruits contain one, two or three seeds in a very tough pod from which it is difficult to free the seed without damaging the seed coat, damage which seriously affects or totally prevents germination. Cutting off one edge of the fruit and sowing whole fruits will hasten germination. Germination is uneven and though stumps can be raised in one season (sown June, field planted March), late germination and slower growths will continue from the same bed the second and third year thereafter. Growth in the first three years in the field is disappointing, but if blanks are filled from one nursery sowing in the second and third years, a stand of vigorous plants varying from 2½ ft. to 15 ft. should be obtainable in six years. The seedlings, like *Afzelia*, often show a natural die-back to ground level whether fired or not and it is this that has led to initial disappointment. Termite and browsing damage appear to be negligible but Spring hares are reported to be a nuisance.

Some success has been obtained by Missions around Tabora in planting with large cuttings about 10–12 ft. long, but the method is not very suitable for large-scale work and is rather unreliable. Not more than 5–10 per cent of the cuttings strike as a rule. The best results are obtained with straight, young saplings, but this merely enables one to transplant promising young trees. It does not increase the population. The best season for striking cuttings is the period August–September, *not* during the rains.

The tree is rather slow-growing in its usual habitat. In areas with a rainfall of 30 in.–40 in., mature trees are usually 80–100 years or more old. In wetter areas, for example, in Nyasaland with a rainfall of 60 in. per annum at 1,600-ft. elevation, planted trees are reported to have attained diameters of 18 in. in from 30 to 40 years. At Tabora 15 years old trees raised from large cuttings at Kipalapala Mission had reached a height of 25 ft. and diameters up to 10 inches, but these were probably 6–10 ft. high when planted.

Selected hulled seed averages about 2,000–2,200 to the pound. The seed should be sown about one year or longer before planting for the production of stumps. Sowing is best done under a light mulch of dried leaves by pressing into the upper level of a sandy tilth to allow of the easy raising of the cotyledons. If this is done in the rains, little or no shade should be required, but in the dry season shelter and water should be provided.

Tamarindus indica (Tamarind)

A handsome, evergreen, indigenous tree which occurs throughout most of the drier parts of the country. It is a conspicuous shade tree in parts of Sukumaland and would be very suitable for ornamental planting around rest camps or *barazas*. The timber is hard, red, and tough, commonly used by Africans for walking sticks. The pod contains a soft, edible pulp with a rather astringent taste which is an article of commerce in some parts of the world, being used as a source of vitamin C and as an ingredient of chutney. It has also been used to stabilize the soil of emergency landing grounds.

There are no reliable data regarding methods of planting but preliminary trials have shown that it can be raised easily from seed by direct sowing on tied-ridges. The seedlings are, however, inclined to check after the first year, as so often happens with indigenous dry forest species, and may take a long time to get away. The tree is believed to be very slow-growing. The seeds are easily collected but are very likely to be attacked by weevils. The pulp should be cleaned off thoroughly and bad seeds removed by floating them off. The good seed sinks and must then be dried before storage.

DESTOCKING AND CULLING IN TANGANYIKA

By J. W. T. Holloway, Senior Livestock Officer, Tanganyika Veterinary Department

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Organized culling or destocking was first introduced into Tanganyika in the thickly populated Mbulu district of the Northern Province and is now also being carried out as part of the development programme in all districts of the Central Province, in the main portion of the Lake Province known as Sukumaland and in the Nzega district of the Western Province. The areas concerned contain nearly two-thirds of the cattle population of Tanganyika. With the exception of Mbulu, which is mountainous with a relatively high rainfall, the country is mainly open or semi-open steppe lying at an altitude of 2,500 to 4,000 ft. with a rainfall of 18 to 35 inches.

The grazing consists chiefly of annual grasses such as *Chloris virgata, Chloris pycnothrix, Dactyloctenium ægyptium, Setaria pallidifusca, Brachiaria serifolia, Aristida adscensiounis, Aristida hodeaceum* and *Harpachne schimperii** and is easily trampled out and affected by drought. At present annual weeds, small herbs and other browse plants contribute considerably to the quantity and quality of the forage. In some areas, particularly in the Central Province, the grazing is supplemented by tree browsing.

Water is obtained from holes dug in the sand beds of flood-water rivers, from rain ponds, from seepage areas, from wells and, to an ever-increasing extent, from earthen walled dams and boreholes developed by the Water Development Department and the native authorities.

Conditions are generally suitable for stock raising, for the grazing is sweet and the rainfall and humidity are unfavourable to East Coast Fever ticks—exceptions to this being the Mbulu district, the northern end of Sukumaland where it borders on Lake Victoria and certain parts of the Singida and Kahama districts. Rinderpest has been brought under very close control by mass annual inoculations with attenuated virus.

The initial success of the Mbulu voluntary culling scheme in 1950 aroused widespread interest in other overstocked areas, but it was realized that although a destocking campaign can, by educating the people, be largely successful on a voluntary basis, there are always a few die-hards and it is necessary to have legal powers to enforce the destocking rates on the rare occasions when compulsion becomes necessary.

An *ad hoc* committee appointed by Government in June, 1951, to examine the question of increasing sales in overstocked areas recommended the enactment of legislation to provide for the compulsory sale of a minimum of 5 per cent of the cattle population in overstocked areas as an interim measure to deal with ovestocking until proper land usage schemes could be worked out. The Natural Resources Board and the Livestock Board agreed with this recommendation and, in conjunction with native authorities and administrative and departmental officers, destocking rules were drawn up and are now in force in the main stock areas with the exception of Masailand, where a "gentlemen's agreement" has been made with the Masai, who are a nomadic tribe.

In practice a flat rate of 5 per cent is not imposed, as very small herds of under ten are usually exempted and the rate increased for larger herds. For example, in Ugogo country in the Central Province the approved destocking rates are:—

Size of herd in cattle	*Cattle to be sold or removed from an area per annum*
0– 9	Nil
10–19	1
20–29	2
30–39	3
40–49	4

The cull, in effect, varies from 5 per cent to 10 per cent for herds of ten head and over.

In the Nzega district of the Western Province the rates are rather higher, i.e.:—

Size of herd in cattle	*Cattle to be sold or removed from an area per annum*
0– 9	Nil
10	1
11–19	2
20–29	3
30–39	4
40–49	5

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* This list of grasses was supplied by Mr. H. J. van Rensburg, to whom acknowledgment is due.

and upwards at a similar rate; the overall result is a cull of just over 10 per cent. The higher rate was imposed at the request of the native authorities themselves.

In the central part of the Mbulu district where land deterioration had by 1949 reached a serious stage, higher rates than the above are now in force as the critical situation called for more drastic measures.

In the Kondoa district of the Central Province, amongst the Warangi, the method of deciding on the destocking take-off is based on an estimation of the carrying capacity of each village area and stock numbers in each area must be reduced to the approved number at a rate not exceeding 20 per cent per annum. In this area, as in the Mbulu district, stock numbers are based on stock units, a unit consisting of one head of cattle or one donkey or two unweaned calves or five sheep or/and goats.

In all destocking campaigns the owner is given the option of selling his stock which is in excess of the carrying capacity of the land, or removing it to an understocked area. In order to make the alternative a practical one, new areas are being developed in tsetse infested regions usually by bush clearing, although experimental spraying with insecticides is also being tried out, and by developing water by boring or by the construction of dams; this work usually being performed by, or under the supervision of, the Water Development Department.

The whole problem is not really one of too many stock, but of too great a concentration on "fly"-free and East Coast Fever-free areas, and therefore a policy of expansion is combined with one of encouraging sales of unproductive and unthrifty stock.

While stock are undergoing reduction in numbers within the congested areas the condition under which the optimum number is kept is being steadily improved by the introduction of dry-season grazing reserves, rotational grazing and, where necessary, controlled burning. This, together with improvement of water supplies, the careful siting of *bomas* to allow for natural drainage in the rainy season and more attention to herding methods and the castrating of all but the best bulls, is slowly resulting in a sound state of animal husbandry, and a start has been made with the issuing of improved types of East African Zebus and Indian × Tanganyika Zebus to selected African cattle owners in the main cattle areas.

In Sukumaland there is, in addition to culling sales, a firm policy of dispersal of cattle in excess of the carrying capacity of the densely populated areas to regions adjoining the outer fringes of the occupied areas. Within these outer areas, which lie east, south-east and west of the main areas, there are expanses totalling some 5,000 square miles consisting mainly of land marginal for agriculture, due either to poor soil types or insufficient rainfall, and this land is in the process of being developed for ranching African herds by constructing water supplies and clearing tsetse fly habitats.

Within the central or mixed farming zone of Sukumaland the aim is to make dairying the main concern of the cattle owners, principally by necessity, because of the smaller herds and the need for milk in the human diet, any milk surplus to domestic needs being made into dairy products, mainly clarified butter or high-grade ghee.

Although efforts are being made to increase the local consumption of beef, small stock still form the main source of meat for the local population and will, therefore, continue to be kept in the agricultural zone along with the dairy herds.

The Sukumaland livestock restriction rules are enforced by the parish councils, and the long-term policy includes the use of more advanced methods of animal husbandry such as the making and storage of hay or silage, the cultivation of special fodder crops and an increase in the use of grazing reserves on a rotational system, a practice, first introduced over ten years ago, which lends itself to pasture improvement work. These measures, with the exception of the establishment of grazing reserves, are by no means easily and freely accepted and it will require much effort and time to introduce them on a satisfactory scale.

In the ranching zones the aim is to develop large-scale rotational grazing reserves with a burn in each section every four years to check bush regeneration. In the demarcation of these reserves use is made, as far as possible, of natural boundaries such as rivers and roads, but where necessary fire-breaks are ploughed.

Much valuable information regarding ranching methods suitable to Tanganyika conditions is being obtained by the Veterinary Department through its pilot ranching schemes on the Mkata Plains, situated in the Eastern Province and typical of many unoccupied areas of Tanganyika. These plains, which extend to 350 square miles, are mainly tsetse-free flood plains, but sufficient high ground, though "fly"-infested, is available for wet-season grazing, although the extent to which this retreat area can be used depends on the progress of large-scale tsetse eradicating operations now being undertaken by the East African Tsetse Research Organization.

Although the plains have only been in use for two years, preliminary data is being collected in connexion with such points as carrying capacity of both dry and wet grazings, growth and breeding rates of various types of cattle indigenous to East Africa, the control of disease, the development of permanent water supplies and the various problems involved in the control of dry-season grass fires over wide open areas.

The original aim was the development of a pilot ranching scheme stocked by the purchase of indigenous heifers from various parts of Tanganyika and some Borans from the north of Kenya. But, with the growth of destocking campaigns in overstocked districts, Government has purchased a number of immature cattle in order to prevent too many finding their way to the slaughter floor too early. Thus a scheme for the purchase, holding and fattening of immature males was approved and several thousand head are being held on the Mkata Plains as a separate unit in addition to the ranching herds of some 2,000 head. It has been found that there are four golden rules to success in any destocking campaign: (*a*) fullest possible propaganda before any other action is taken; (*b*) allow the owner to make the final selection of the animals to be sold; (*c*) give him the alternative of selling or removing to a new or understocked area the stock in excess of the carrying capacity of the land he occupies; and (*d*) last, but by no means least, provide proper livestock markets under the control of a livestock marketing officer to ensure that the seller gets a fair price and the market is efficiently run.

Tanganyika is fortunate in having a large canning factory which can deal annually with considerable numbers of culled cattle of the type which the butcher is not normally keen to buy. As elsewhere in the world, increased local prosperity has resulted in a higher consumption of meat and this, together with the canning facilities already mentioned has provided a demand well able to deal with available supplies.

The benefits resulting from the reduction of stock in overstocked areas to the true carrying capacity of the land is becoming apparent to the stock owners and now the practice has begun it should develop its own momentum.

TIMU, AND THE VANISHING FORESTS OF NORTH-EAST KARAMOJA

By H. C. Dawkins, Forest Department, Uganda

(*Received for publication on* 13*th October*, 1953)

Eggeling [1] and other writers have drawn attention to the fact that the majority of Uganda's forests are young and still show a marked tendency to spread. There are in fact very few uninhabited areas in Uganda where forest is not spreading or colonizing, a process which causes some alarm to those responsible for tsetse control. But in Timu, and the woodland and forest along the Karamoja–Turkana escarpment of which it is typical, we have an apparent exception. Here one finds clumps and strips of closed forest obviously receding in the absence of agriculture and in spite of evidence that the climate and soil are favourable. Timu is a forest reserve of 43 square miles established in 1942 for the protection of a valuable catchment basin and dry-season grazing ground. It is situated in the north-east of Karamoja on the gentle but dissected west-facing slopes behind the escarpment which overlooks Turkana. Thomas [2] has briefly described the vegetation, styling it the "most well-developed woodland in North Karamoja". The "forest" lies between 5,000 ft. and 6,000 ft. in altitude, reaching the latter height at its eastern limit, the summit of the escarpment at Kanadap.

Little is known about the Timu climate, as the nearest meteorological stations are over 80 miles away in entirely different country. But from the appearance of its vegetation, particularly of the forest shrub and herb layers and the floristics of the grassland, the mean annual rainfall can hardly be less than 40 in. with about five months "dry", i.e. with less than 2 in. fall per month. The higher levels are evidently much affected by mist, which although rarely witnessed as the area is seldom visited during the rains, is indicated by the abundance of *Usnea* lichens at altitudes over about 5,700 ft. Mist conditions may have resulted in an overestimate of rainfall, though it can hardly affect the lower levels to the west which abound in trees of a "Guinea" rather than a "Sudan" climate (in the genera *Terminalia, Dombeya, Vangueria, Cussonia,* etc.).

The Timu vegetation is here classified into three main types:—

Closed Forests

(1) *Juniperus* forest at around 5,800 ft. and above with *Olea chrysophylla* and *Catha edulis.*

(2) *Acacia-Euphorbia* forest below that level, also with abundant *Olea.*

Wooded Grassland

(3) *Themeda-Hyparrhenia* grassland with woodland of *Acacia, Cassia* and numerous other species.

The forest is very limited in extent, being largely concentrated on stream banks but not confined to them; many small patches are centred on groups of termite mounds and others have no visible topographical justification at all.

In the islands of juniper forest *Juniperus procera* is the tallest and most conspicuous tree, attaining heights up to 70 ft. and basal girths of 9 ft. Good specimens are frequent, and those which stand in fully closed forest immune from fire show healthy crowns and rising leaders. The juniper sometimes occurs in pure stands over small areas but is more commonly mixed with *Olea, Catha, Mimusops kummel, Ficus* spp., *Pappea ugandensis* and occasional *Albizzia maranguensis.* The canopy of such communities is distributed from 50 ft. to within 20 ft. from ground level where it merges with the trees and shrubs of the understorey. The latter is not well developed as a layer but is frequently dense and impenetrable. It is dominated by *Teclea nobilis,* frequently associated with *Trichocladus malosanus, Gelonium procerum* and a *Strychnos.* Lianes of the Apocynaceae and Ampelidaceae are common but do not form a high proportion of the canopy or gaps. The forest floor is well covered by a typical "dry forest" association of acanths (*Mellera, Crossandra* and others) with a few specimens of a forest *Setaria* and *Panicum.* A few seedlings of *Catha, Olea* and *Teclea* may be found but a diligent search failed to reveal any seedling juniper below 6,000 ft. altitude.

The lower-level *Acacia-Euphorbia* forest seems to be poorer in species than the juniper community. Trees of *A. hebecladoides, E. candelabrum, Olea* and *Ficus* spp. fill the very irregular canopy, in which occasional specimens of *Albizzia, Terminalia brownii* and *Pappea* are scattered. The understorey is largely of *Teclea* with few true forest shrubs but often a dense thicket of the "forest-edge" types, including species of *Acalypha, Carissa, Phyllanthus, Lantana* and others. The community in fact achieves its status of forest more by the absence of grass and intolerance of fire than by development of specialized communities.

Both types of forest have in common a complete incompatibility with fire. All their shrub and herb species are fire-sensitive and quite incapable of surviving repeated scorching, if not a single burn, while the community as a whole is barely inflammable and apparently cannot support a widespread internal burn even in the dry season.

Outside the forest islands are the far more extensive wooded grasslands, varying through all degrees of tree density but ruled by the relatively invariable factor of grass fires. As Thomas has described, the grass communities show characteristic degrees of development depending on distance from dry-season water supplies; four-foot *Hyparrhenia-Themeda* associations distant from them and one-foot *Sporobolus* with *Chloris* and *Cynodon* where the grazing is more continuous.

The best defined of the woodland communities is the *Acacia-Cassia* association (*A. seyal var. multijuga, A. hebecladoides* and *C. singueana*) found on the normal broad rounded ridges. This is accompanied by very sparse *Themeda, Setaria sphacelata* and *Hyparrhenia* or occasionally by bare soil. In other parts of Dodoth County, alongside the Timu area, this same community is almost universal on such sites and equally universally accompanied by bare soil, even in the rains. The even-aged appearance of most patches of the *Acacia-Cassia* community and its marked association with potentially arable sites strongly supports Thomas's suggestion of past agricultural occupation, by a tribe ("Dopeth") now moved to the Sudan. The community also owes something to intensive grazing along the present Dodoth stock routes, which tend to follow the water-divides especially where these are broad and relatively unencumbered with rock. In Timu itself, this process is less serious than elsewhere in Dodoth, but bare soil is to be found indicating the same potential source of degradation.

The *Acacia-Cassia* association contains another 20-odd tree species, which are common to the other woodland communities. As no zonation or special distribution of these was observed, they are given here in one list:—

A. hebecladoides,
A. seyal var. multijuga,
Cassia singueana,
Combretum guenzii,
Commiphora spp.,
Croton macrostachys,
Cussonia arborea,
Dichrostachys glomerata,
Dombeya rotundifolia,
Erythrina abyssinica,
Euphorbia candelabrum,
Fagara chalybea,
Ficus spp.,
Grewia bicolor,
Gymnosporia senegalensis,
Harrisonia abyssinica,
Heeria reticulata,
Lannea schimperi,
Pappea ugandensis,
Pistacia lentiscus var. emarginata,
Rhus vulgaris,
Steganotaenia araliacea,
Terminalia brownii,
Vangueria apiculata,
Ziziphus abyssinicus.

Apart from the *Acacia-Cassia* association described, only two other specialized woodland communities occur. One of these is caused by the usual fire-protective effect of rocky outcrops, and is recognized simply by greater density of trees and paucity of grass. Should grass be absent, and consequently the community free of fire, then the forest shrub community is found and the woodland trees tend to give way to the more truly forest species. The other specialized wooded grassland community is the *Acacia seyal-Balanites* association, of very limited extent in Timu and confined to near-level ground in the valleys. Here some of the largest *A. hebecladoides* of the area are found, sometimes gregarious in small but pure stands.

At the north-eastern extremity of the Timu reserve, where the steep valleys of the Tultul River leave the slopes of Kanadap, there is a remarkable ravine forest with distinctly hygrophytic features. Here there are masses of true high-forest lianes (*Urera, Landolphia*) and sappy herbs (*Impatiens, Laportea*) under a well-developed understorey layer in which *Chaetacme aristata* supplements the commoner *Teclea*. The canopy contains the common Timu species but is enriched with *Albizzia gummifera*, and *Ziziphus pubescens*. The forest is remarkably similar to some montane communities of Elgon and even of the Kigezi district but is not typical of Timu, being a topographical peculiarity in a specially favourable microclimate.

The main ecological interest of Timu lies in the thoroughly unstable forest edges where the future of the vegetation cover is being decided. As already described, the closed forest is, as in other parts of Uganda, entirely intolerant of fire. Similarly, most of the tree and herb species of the wooded grassland are intolerant of shade and probably of undue tree root competition as well. It is therefore usually possible to determine whether a forest edge is advancing, receding or stable, by the distribution and vigour of characteristic species along a transect through the edge.

An advancing forest edge is usually clearly shown by a belt of herbs, climbers and shrubs which are partially tolerant of fire, in that they can stand limited scorching but are eventually killed off by too fierce burns. In Timu the principal colonizers are:—

Acalypha volkensii,
Carissa edulis,
Phyllanthus spp.,
Millettia sp.
Heteromorpha spp.,
Dodonea viscosa,
Vangueria apiculata,
Rhus spp.,
Smilax sp.,
Lantana sp.,
Vernonia spp.,

together with numerous unidentified leguminous and ampelidaceous climbers.

These species exist in precarious competition with the *Themeda-Hyparrhenia-Setaria* grass communities; reduced fire intensity results in easy victory for the forest colonizers, while fiercer fires permit the grasses to spread into the forest edge thereby carrying the fire still further. The colonizing shrubs are materially assisted by shade from the trees which arise behind their protection, as the shade is directly suppressive both to the grass and the fires. Similarly isolated but especially shady trees, often of woodland species (*Vangueria, Pappea, Pistacia*), give starting points for the spread of the shrubs.

In Timu there is an overwhelming preponderance of receding forest edges and advancing grass. One of the commonest sights in the forest is the scorched, dying or dead forest remnant of juniper, *Olea, Teclea* or *Catha*, grown up in forest but now surrounded by grass and burnt shrubs and beyond hope of recovery. In some places the whole forest structure may be seen, with practically every shrub dead, young grass growing up and a few yet living trees testifying to the recent date of invasion by fire. The process of gradual forest destruction by fire is more conspicuous in the juniper forest than in the lower-level *Acacia-Euphorbia-Olea* formation. It is not, however, any less serious in the latter, where although most of the large trees are fire-tolerant and therefore persistent yet the undergrowth is just as sensitive as that of the juniper forest.

There is one other important agent of forest destruction besides the spectacular process of fire. Thomas drew emphatic attention to it when he wrote "if the ground cover is destroyed by over-grazing and the rate of run-off increased, the forest may soon die out". The run-off from Karamoja soils has to be seen to be believed, and Timu is no exception to the rule. Within a few minutes of the onset of rain—even gentle rain—the whole grassland surface becomes a sheet of moving water with the meanest cattle path carrying rushing streams of turbid water. Under the forest thicket at the same time, surface water is absent or at the worst confined to well-marked hollows or stream beds. That this situation is a dangerous one is shown by the frequent instances of exposed roots and resulting death of trees, grassland species being the worst situated for this form of damage. The soil erosion process, while more irrevocable is fortunately less widespread in Timu than forest destruction by fire, and can be arrested before becoming serious. But its existence and the existence of adjacent already devastatingly eroded areas in the same vegetation type, show most clearly what can and will happen to Timu if the writing on the wall is ignored.

Three ecological problems without clear solutions arise from this discussion; the disproportionate seriousness of fires where grass is coniderably reduced by grazing, the current failure of juniper to regenerate, and the reason for the extremely high run-off.

As to the first, the encroachment of fires on forest edges is a slow but very real process, and yet over the majority of Uganda forests colonization will triumph over grass fires where these are not deliberate "late" burns. Timu has also the favourable influence—from the point of view of fire reduction—of dry-season grazing. Either the grass is fired deliberately early to produce an immediate flush of green pasturage, or burning is withheld for the benefit of dry pasturage, in which case the grass is well eaten and trodden before being burnt. In either case fires are likely to be less severe than average. Only in the case of late burning the grass itself may be downtrodden and scanty but the forest edge vegetation is likely to be drier and in a sufficiently dry year is conceivably inflammable. There is probably also an inherent weakness in the resistance of African tropical montane forests to fire, compared with their lowland homologues. Michelmore [3] remarked on the tendency for vegeation of the 4,500 ft. to 6,000 ft. zone to develop grassland rather than forest and suggested that at these altitudes the temperature-water relations of the soil were intrinsically unfavourable to tree growth. In fact, as already stated, the phenomenon of serious encroachment of fire on the Timu forest patches still requires a satisfactory explanation. It should be sufficiently obvious that proper management of the area, whether aimed at a forest or grass cover, will require careful ecological study of the existing precarious balance between the two formations.

With regard to the current failure of juniper to regenerate, two possible explanations occur. The climate might be unsuitable at the present time or for quite distinct reasons suitable vegetation communities may no longer exist. The climatic argument is the least likely, as young juniper around six inches in diameter and twenty feet high is often seen, both healthy in thicket or forest and dead or dying in grassy glades. Such trees are unlikely to date from a different climatic era from the present. On the other hand they certainly grew up in a different plant community, as juniper is fire-sensitive and scarcely likely to grow up in fire-swept grass. It seems therefore either that the "forest edge" type of shrub thicket was formerly more extensive than now, or that the thickets were at that time, less than a century ago, less liable to be burnt and mostly in an advancing state. If the Timu country was indeed extensively cultivated then, burning conditions would not be as severe as they are under a dominantly grazing régime.

Thomas ascribed the high run-off of Karamoja soils to surface compaction of the soil due to trampling by cattle, and to the effect of direct insolation and rainfall on entirely unprotected surfaces. These explanations may suffice for the heavily overgrazed plains but are hardly sufficient for the less populated tract of Timu. A hard impervious soil crust certainly exists, serving apparently to arrest sheet erosion as well as to prevent water percolation. But how it arose and how it may be modified for the benefit of underground water supplies is not yet satisfactorily worked out.

SUMMARY AND CONCLUSIONS

The Timu Forest Reserve in Dodoth county, North-east Karamoja, Uganda, consists of a tract of wooded grassland with numerous small strips and clumps of thicket and closed forest. The forest blocks are conspicuous for their *Juniperus procera, Olea chrysophylla, Acacia hebecladoides* and *Euphorbia candelabrum*, and show a dense understorey and shrub layer with *Teclea nobilis* preponderating. The area is interesting because forest is losing, and has lost, much ground to wooded grassland, primarily because of fires originating in the latter. It is emphasized that management of the tract for whatever purpose will require a very careful study of the delicate balance between grass and closed forest, together with the connected factors of grazing intensity and compaction of the soil surface.

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This paper is the result of two visits to Dodoth at different times of year. The writer has been much assisted by the opinions and encouragement of Mr. C. Swabey and by unpublished notes of Mr. R. G. Miller, neither of whom are responsible for any unsound arguments which occur.

REFERENCES

[1] Eggeling, W. J. "A review of some vegetational studies in Uganda." *Uganda Journal*, 12 p. 139, (1948).

[2] Thomas, A. S. "The vegetation of Karamoja District, Uganda." *Journal of Ecology*, 31, (1943).

[3] Michelmore, A. P. G. "Observations on tropical African grasslands." *Journal of Ecology*, 27, p. 282, (1939).

INTENSIVE EGG PRODUCTION FOR THE SMALLHOLDER IN UGANDA

By H. L. Manning, Empire Cotton Growing Corporation, Namulonge, Uganda

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Increased costs of imported farm products into Uganda have offered the smallholder a challenge—can he, in fact, replace the imported produce and, perhaps, even under-sell much of it? In particular, new-laid eggs are generally in short supply in Uganda and, even when available, are very expensive. As a result the writer considered it worthwhile to conduct an experiment to see what return could be obtained from poultry on the home scale. It was thought also at the time that, were the experiment successful, it would be possible to make up foods from local foodstuffs, according to various well-tried formulæ given in the *East African Agricultural Journal.*

Reference books are available for the beginner outlining systems of keeping poultry to obtain maximum egg production. There are various systems, each with its own supporters and let it be said at once that, to a keen gardener, the free range system was out of the question. Moreover, in any market gardening community such a system could only lead to strife. Since the full "battery" system with birds in separate cages required an organization beyond the capacity of the average householder this also was ignored. Many people no doubt have tried the small poultry run with permanent expensive mesh wire, and results could not be said to be impressive—this is hardly surprising as the grazing usually disappears within a short time, to say nothing of the "fouling" of the land. The important question put simply was: "Could poultry be expected to give satisfactory results without free range but in some form of confined pens?"

This note is a record of eggs actually obtained from four birds in 300 days. During the period 914 eggs were obtained, giving an average of nearly 230 eggs per bird. The details of the trial may be of some interest to the small producer. It should be emphasized that this note is not meant to be a comparison of systems, but a record of results obtained from one system that happened to be convenient for the author's purpose.

Pens

Since cheapness was of primary importance, the system finally adopted was to construct light frame pens capable of being easily lifted by two persons. Only rough grazing land was available so that permanent wooden wheels at one end—an advantage on lawns—appeared to be of little value. These pens were made of light wood from packing cases, then treated with wood preservative and allowed 4 to 5 square ft. per bird. Three fundamental features should be emphasized. Firstly, clean, fresh water should always be available and this is best effected from simple fountains. Secondly, birds should have access to food and grit only through a grid and at specified periods; that is, they are prevented from trampling or scratching the food as would be the case in open troughs. Thirdly, the pens should be moved according to the denudation of vegetation. During the course of this experiment it was found that four birds in a pen picked the vegetation clean in about three days, but in very wet weather they were moved every two days. Re-growth takes place within six weeks so that the rotational area need not be large. A sketch plan of a pen and shelter is illustrated in this article.

A water fountain is easily made from the well-known inverted bottle arrangement, with a wide-mouthed can as the reservoir (a butter tin makes an ideal reservoir). The dimensions of the pen above were length about 6 ft., width about 2½ ft. and height not less than 2 ft. This latter will, of course, depend on the breed of bird. In regard to the wooden bars making the feeding grid, distances between bars were about 3 in., with the individual width of bar being about the same. This then allows 6 in. feeding room per bird and, of course, gives an equal feeding opportunity to each bird irrespective of its physical prowess. Wooden troughs were chosen in preference to metal, though this may be a matter of individual preference—doubtless the resident veterinary officer would sustain the objection to a metal feeding trough. The shelter and laying boxes (of which no more than two are necessary) need no comment beyond the statements that the bottom of the weather board (*see* illustration) should be almost in a horizontal line with the roosting perch and that the laying box has a wire bottom raised from the ground. That is, at all times the birds had protection from very heavy rain. Constructional details are omitted as being well within the capacity of anyone with a hammer and a saw.

Birds

Choice in the question of suitable birds was governed by circumstances—here in Uganda, the Veterinary Services maintain for sale large flocks of Black Australorp and Rhode Island Red birds. At the outset of this experiment the officers of this department showed a keen interest and were instrumental in securing six Australorp and two Rhode Island Red birds. These were selected at random and four Australorps were put in one pen. Since the second pen contained mixed Australorp and Rhode Island Red birds, it was not possible to specify the separate performance of the former: this pen was not, therefore, relevant to the main trial.

At the time of purchase in July, 1952, the birds were approximately six months old. Desultory laying was recorded during the latter part of that month, and full production commenced from the beginning of August. The birds were therefore not younger than seven months or older than eight months when the records were initiated.

Feeding

On the principle that a hungry bird will eat more (and presumably lay more eggs) than a bird which has continuous access to an unlimited food supply, it was decided at the outset to provide 2 oz. twice daily per bird per day. This may be a matter of opinion but the results obtained seem to justify this belief. Since the foodstuffs available in Kampala were not always the same, it was necessary to check the weight of the standard container (a small milk tin was found to contain approximately 2 oz.). Food at a rate of 2 oz. per bird was moistened but not excessively wetted and placed in the troughs each morning about 8.30 and again in the afternoon about 5 p.m. At the time of the afternoon feed the birds would have completed their desultory picking of weeds and grass in the relatively confined space. There were, therefore, few occasions when they were not hungry enough to finish their allotment within half-an-hour. Oyster shell grit was always available.

Although whole grain, as part of the feeding routine, is often recommended, and indeed by some considered essential, none was fed to the birds during the 300 days of the experiment. Since production, in fact, averages over three eggs per day from four birds, the results perhaps speak for themselves. Various proprietary brands of prepared foodstuffs were tried. It would appear that so long as the protein content is about 20 per cent and that water and oyster shell grit are freely available, the fowl is entirely capable with this limited mixed grazing of acquiring the wherewithal to produce the necessary egg.

Production

Perhaps the most interesting aspect of this trial was that production was maintained at a fairly constant rate throughout the period. That is, one might expect a disproportionately high laying rate during part of the time followed by an equally low rate during the remainder. This, however, was not so. Data below show that the lowest monthly rate from four birds was 2.6 eggs per day. The highest rate was 3.7 eggs per day from the same number. Therefore, with four such pens one could expect between 10 to 15 eggs per day:—

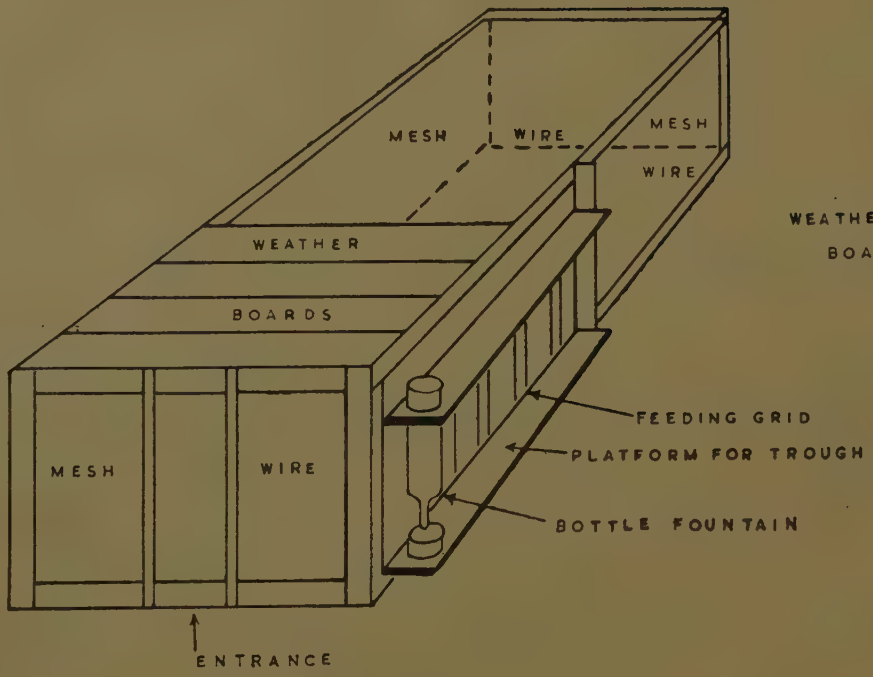
Month	*Days*	*Eggs**	*Rate per day**
August	31	115	3.7
September	30	111	3.7
October	31	98	3.2
November	30	94	3.1
December	31	86	2.8
January	31	95	3.1
February	28	78	2.8
March	31	82	2.6
April	30	80	2.7
May (1-27)	27	75	2.8
Totals	300	914	
Means			3.05

* Four Birds.

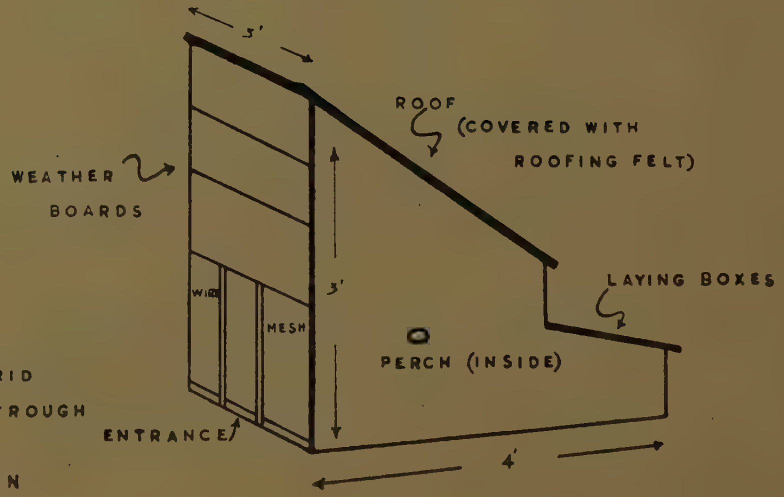
Before leaving this aspect, the reader may be interested in some calculations based on the above data. If a guaranteed egg production (9:1 probability) is desirable, say for 12 eggs per day, then 21 birds would be required during the poorest laying month. Of course, there would be periods when the daily average, for a month with this number, would then exceed 18 eggs per day. This latter is of greater concern to the large-scale producer.

This trial has shown, under Uganda conditions, that relatively high production can be achieved from confined birds on a small scale. The question of costings is one best related to the availability and price of local foodstuffs. Various formulæ have been given in past issues of this *Journal*. These have given the writer equally satisfactory results in another part of the tropics.

Sketch of poultry pen for four birds.



Hen house and laying boxes.



FERTILIZER EXPERIMENTS ON GRASSLAND IN THE KENYA HIGHLANDS

By **H. W. Dougall, Department of Agriculture, Kenya**

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In 1926 attention was directed by the Committee of Civil Research [1] to the grasslands of Kenya, when this Colony was selected by it as the most suitable for pursuing an inquiry into the mineral content of natural pastures. Boyd-Orr, who directed this investigation, selected four districts (Naivasha, Athi Plains, Nakuru, Molo), in which he studied the chemical composition of natural herbage as affected by soil and climate. Results of preliminary work indicated clearly that, in three of the four districts, pastures were deficient in all mineral nutrients and also in protein. Phosphorus was the element most deficient, and he considered it to be the factor limiting the assimilation of other minerals by the plant. Boyd-Orr inclined to the view that if phosphorus were supplied by fertilizers, the amount not only of phosphorus but also of calcium would be increased in the pastures. However, when the most deficient area was treated with fertilizers,* the first direct effect to be measured was productivity and yields of herbage were increased from 25 per cent, when common salt was used, to well over 300 per cent where nitrogen and phosphate were used together. It is unfortunate that the composition of the herbage harvested was not reported, but we may infer that its mineral status was enhanced, for it is recorded that when stock were allowed access to the plots at the end of the test, they "showed a marked preference for those which had been fertilized, while controls were left practically untouched". It was observed that where phosphates had been applied the herbage maintained its green appearance for a longer period during subsequent dry weather.

This pioneer work of Boyd-Orr and his colleagues was not advanced to any marked extent in the years which followed, but nevertheless, it does seem that a proper appraisal of grass was being sought. It was beginning to be regarded in all its forms as: (i) the "raw-material" factor limiting the formation of milk, meat, mutton, wool, etc., and (ii), in the form of a ley, as an integral and probably pivotal crop in a suitable system of alternate husbandry.

The need for field experimentation to test these views became more urgent in recent years and in 1950, under the Government-sponsored "Highland Fertilizer Scheme", a restricted number of field experiments were carried out with the object of examining the effect of certain fertilizers on the productivity of natural pastures and established grass, and on the establishment of suitable ley swards. These experiments demonstrated beneficial effects of phosphate on ley establishment, and marked herbage-yield responses to nitrogen on established leys and certain natural pastures. Lime and potash at the levels applied appeared to have no appreciable effect on the productivity of the few permanent pastures investigated.

In 1951 the Department of Agriculture extended the scope of this work and studied the role of a phosphatic fertilizer, single superphosphate (P), and a nitrogenous fertilizer, sulphate of ammonia (N), on ley establishment and on the productivity of established grass and natural pastures, including rough grazing. These studies were undertaken on different kinds of soil, with different herbage species, and in areas of varying altitude and climate, with the object of (i) obtaining an assessment of optimum dressings of these fertilizers, and (ii) determining responses to P and N as measured by productivity and nutrient value of the herbage.

In ley-establishment trials, factorial combinations of P (18 per cent citric soluble P_2O_5) and of N (20 per cent) were used. There were 16 treatments and two replications. Fertilizer dressings, applied at the time of seeding down were: 0, 30, 60, 120 lb. N per acre and 0, 36, 72, 144 lb. P_2O_5 per acre; and each of the following grasses—Rhodes, Molasses, Cocksfoot and Kentucky fescue—were sown in combination with a legume—Lucerne or Seradella.

In the permanent grassland trials, factorial combinations of the same fertilizers were arranged in the form of a quasi-Latin square, with 18 treatments and two replications. Fertilizer dressings were: 0, 15, 30, 60, 90, 120 lb. N per acre and 0, 36, 72 lb. P_2O_5 per acre, broadcast at the beginning of the growing season. Nitrogen was re-applied at the same levels after each time the herbage was cut.

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* A mineral phosphate at 10 cwt. per acre, sulphate of ammonia at 1 cwt. per acre, salt at 5 cwt. per acre, lime at 5 tons per acre: the ground was tilled and broken up before the fertilizers were applied.

Herbage was cut when it had reached a stage of growth considered suitable for stock grazing. Yields of fresh material were recorded, and samples were taken for dry matter determinations and chemical analysis.

Soil samples to a depth of six inches were obtained from each plot of each experiment prior to the initial application of the fertilizers and again after each herbage cut; with permanent grassland, however, the soil samples were taken before re-applying nitrogen. Final samples were obtained in December, 1951.

Herbage samples obtained from the first cut in each kind of trial were analysed for crude protein, phosphoric oxide (P_2O_5), and lime (CaO).

Values obtained for these components, which appear in Tables I–IV, relate specifically to material derived from the first cut.

Effect of Phosphate (Tables I and II)

In ley trials the main effect of applying the phosphatic fertilizer to the seed-bed was to promote early establishment. Mean yield responses for both leys and permanent grassland followed logarithmic curves resembling those obtained by Crowther and Yates [2] for root and cereal crops in England. Chemical analyses showed that the crude protein of permanent pastures was usually increased by the phosphate applied, but with sown leys protein content was occasionally depressed. In both instances, however, applied phosphate promoted an increase in total output of crude protein per acre. As might be anticipated, phosphorus increased the P_2O_5 status by both ley and permanent grassland herbage, and the yield of phosphoric oxide removed in the herbage increased also with the amount applied.

In sown leys the general effect of phosphate was to depress the ash content of the herbage and the lime content of the ash. This latter constituent was usually depressed in soils with a relatively high pH; where the soil pH was low, or relatively low (4.8–5.0), the lime content of the herbage was usually enhanced. On the other hand, as Boyd-Orr anticipated, the lime content of permanent pasture herbage benefited from the phosphate applied. For both leys and permanent grassland, however, the fertilizer caused an increase in the total lime removed by the herbage.

Effect of Nitrogen (Tables III and IV)

Increasing levels of sulphate of ammonia increased the yield of dry matter of newly sown leys and of permanent grassland at each increment of phosphate applied. No interval applications of the nitrogenous fertilizer were made to the sown leys, but a single dressing given to the seed bed in adequate amount (20–30 lb. N) usually assisted establishment. After the herbage was cut for the first time, however, measurable residual effects were rarely obtained, except occasionally at the higher levels of application. It is possible that, when applied at somewhat extravagant rates at the time of seeding down, this fertilizer may be largely wasted, either on account of leaching or because a juvenile root system is not fully capable of utilizing it. In order further to increase productivity in the young ley, the possibility of applying a second dressing of nitrogen would seem worthy of investigation, especially under conditions of favourable rainfall.

In the trials on permanent grassland nitrogen was reapplied after each herbage cut, and results indicated that, where rainfall was adequate, there were advantages in using nitrogen in this way. From a practical standpoint, however, constant use of nitrogen can be advocated only in circumstances which will be discussed more fully later. Similarly, nitrogen applied to the seed bed of the ley, and to permanent grassland, increased the crude protein content of the herbage, and yields of crude protein per acre were related directly to the amount of nitrogen supplied by the fertilizer. On newly sown leys a general tendency of nitrogen was to depress the percentage of lime contained in the herbage. This effect was not observed with permanent pastures, but, on both forms of grassland, nitrogen led to an increase in the total yield of lime removed in the herbage. This effect was most marked with permanent grassland.

Nitrogen in no way affected the phosphoric oxide (P_2O_5) content of herbage of newly sown leys, but data obtained in 1952 indicated that it can reduce proportionately the P_2O_5 content of permanent pastures. On the other hand, there was an increase in the total amount of phosphoric oxide removed in both forms of herbage by each increment of sulphate of ammonia applied.

Soil Reaction and Phosphate (Table V)

Soil reaction (pH) in relation to the growth of specified crops has been a subject of study for many years, and Crowther [3] has related pH with response to phosphate for such crops as swedes and turnips. A similar relationship, which promises to be of some benefit in assisting to predict phosphate dressings for permanent grassland, is illustrated by data given in Table V. It will be seen that, in terms of yields of fresh herbage, greater responses over control yield were obtained from soils of relatively low pH than were obtained from soils of relatively higher pH, and the degree of significance is much less pronounced at the higher level of phosphate applied. A parallel correlation, but with a degree of significance of only 0.05, was obtained between response to phosphate and pH with newly sown leys. It is considered, however, that where a grass crop is to succeed an arable break, factors other than pH (for example, the duration of the break, the nature of the crop grown, and their fertilizer requirements) must influence profoundly the quantity of phosphate required for ley establishment.

Further work on permanent grassland in 1952 confirmed that not only can yield responses to phosphate be correlated with pH, but that the amount of phosphate taken up by the sward may be related also to pH (Table VI).

Soil Reaction and Nitrogen (Table VII)

It is a well-known fact that one effect of adding sulphate of ammonia to a soil is to cause, eventually, an increase in soil acidity. This effect was demonstrated, significantly, in the short period of a single growing season both for ley and for permanent grassland soils. It will be recalled, however, that the permanent grassland had received more than one dressing of sulphate of ammonia. This effect of sulphate of ammonia on the pH of permanent grassland soils continued in 1952, and has been confirmed since by results obtained from other experiments which include the application of lime. It has been estimated and generally agreed amongst European and American workers [4] that an application of 1 cwt. of sulphate of ammonia (approx. 20 lb. N) to a soil increases the loss of lime by 0.8 cwt. CaO. It would seem desirable, therefore, that this depletion of lime be kept in mind at least, particularly where somewhat heavy dressings, or repeated smaller dressings of this nitrogenous fertilizer, are to be applied to pastures.

Rainfall and Phosphate (Table VIII)

In this country rainfall is neither well distributed nor reliable, yet the need for adequate moisture in relation to normal plant growth, in the presence or absence of fertilizers, is plainly obvious. Data obtained in 1951 indicated that the efficiency of a phosphatic fertilizer in herbage production may not be entirely independent of rainfall, and a study of Table VIII will show how responses over control were related directly to the amount of rain which had fallen in the month prior to cutting. The higher degree of significance in both forms of grassland is associated with the higher level of phosphate applied and, on the evidence available, permanent pastures would appear less dependent on rainfall than newly sown leys. It may be suggested, in partial explanation, that in the more favourable soil-moisture régime associated with permanent pasture phosphoric acid concentration in soil solution may remain more constant.

Rainfall and Nitrogen (Table IX)

The need for an adequate moisture supply in relation to establishing sown leys may be judged from the data given in Table IX. It will be seen that yields of fresh herbage obtained at each level of nitrogen applied are related directly to the rain which had fallen during the month prior to cutting. No correlation was obtained for permanent pastures, presumably because, unlike newly sown leys, the soils of the former maintain a more favourable soil moisture régime by virtue of their surface cover and mature root system.

Use of Phosphates

It would appear from the evidence available that an initial optimum dressing of single superphosphate for establishing sown leys and for improving permanent grassland should rarely exceed 54 lb. P_2O_5 per acre, i.e. 3 cwt. of single superphosphate or 1½ cwt. of double superphosphate. In the 1951 ley experiments, phosphate was applied to the seed bed in single dressings. Whether greater economy could be achieved by repeated applications of correspondingly smaller dressings is not yet known, but evidence obtained during 1952 suggested a single initial dressing as being the most likely way of effectively obtaining rapid establishment. The main effect of phosphate on newly sown leys was undoubtedly to promote their establishment, a residual effect after the first cut being reflected in the phosphate content of the herbage but rarely in dry matter production. On permanent grassland, however, there was some evidence of residual effect, since enhanced yields were obtained by repeated nitrogen applications. It seems feasible that the beneficial effect of phosphate on yield and on nutritive value of newly established grass, established grass, and natural pastures would be increased by periodic top dressings of nitrogen during times of favourable rainfall.

Use of Nitrogen

The evidence obtained during 1951 and 1952 has indicated that for ley establishment, a single dressing of 30 lb. N (approx. 1½ cwt. of sulphate of ammonia), to the seed bed is beneficial. There seems little justification for giving higher dressings initially in the expectation of this fertilizer benefiting growth beyond the first establishment cut. For permanent grassland there may be advantages in applying nitrogen at intervals throughout a favourable growing season in order to increase the productivity of certain pastures, e.g. a natural or established Star Grass pasture, an Nzoia Rhodes pasture, or a Kikuyu grass pasture. The slight increase in productivity which resulted from the use of nitrogen on the rough grazings does not seem at present to justify such treatment being adopted for their initial improvement. Experience has shown that, provided all factors are favourable, 20–30 lb. N (approx. 1–1½ cwt. of sulphate of ammonia), applied on two or three separate occasions during the growing season would be satisfactory dressings.

A system of applying a nitrogenous fertilizer to permanent grassland or established leys should be advocated with caution, however, for such a system will inevitably involve an appreciable outlay on additional stock to utilize fully a greater bulk of herbage in the field before it becomes too stalky and mature, or to utilize it in the form of hay or ensilage; on new fences, permanent and movable, in order to control grazing effectively; and on water supplies for stock. Such a system is also likely to create increased expenditure on phosphates and, perhaps, on potash and lime, and its possible advantages may fall short of expectations in seasons of inadequate rainfall and/or low temperatures and ground frosts, when normal growth may be retarded considerably.

SUMMARY AND PRACTICAL IMPLICATIONS

It has become abundantly clear that the problem of successful ley establishment can be aggravated to a marked extent by weed competition. The presence of weeds must be due, in part at least, to past treatment of the land, and it is important to appreciate that proper growth of sown grasses and legumes should not be retarded in a struggle with weeds. It is considered that seed-sowing should be given the best conditions possible, and a first essential would appear to be the preparation and subsequent maintenance of a clean seed bed of good tilth.

In the experiments described, sulphate of ammonia increased productivity and protein value of certain forms of natural pastures and established grass. It may be applied beneficially at intervals throughout a growing season, but this latter practice can be justified only in the circumstances of sufficient stock, adequate water supplies, fences, etc., or where ample facilities exist for conserving and utilizing the produce. The soluble phosphatic fertilizer could usually be relied on to increase productivity and to enhance the nutrient status of permanent pasture herbage. It is possible that its beneficial effect would be increased by periodic dressings with nitrogen.

At the time of seeding down a ley, a dressing of the nitrogenous fertilizer, at approximately 1½ cwt. per acre, could be beneficial. There is little justification for exceeding this amount. In general, a soluble phosphatic fertilizer has appeared essential to proper ley establishment. An adequate dressing will vary with soil and locality but rarely should exceed 3 cwt. of single superphosphate. When applied at the time of seeding down leys, neither phosphate nor nitrogen is likely to influence productivity beyond an establishment cut, but phosphate may continue to enhance the nutritional value of the herbage.

Observations have shown that nitrogenous and phosphatic fertilizers, and, to a less well-known extent, potash and lime, are able to influence the botanical composition of a sward. At the same time, however, grazing animals can be equally effective in determining herbage composition. For full utilization of the benefits to be obtained from the use of fertilizers on pasture, a high degree of skill in the control of their grazing, with the aim of maintaining a correct balance of desirable species, becomes essential.

REFERENCES

[1] Economic Advisory Council (1931). Committee on the Mineral Content of Natural Pastures, 6th Report, H.M. Stationery Office.

[2] Crowther, E. M. and Yates, F. (1941). *Emp. J. Expt. Agric.*, Vol. IX.

[3] Crowther, E. M. Private Communication.

[4] Sir E. John Russell (1952). Soil Conditions and Plant Growth.

TABLE I.—EFFECT OF P_2O_5 ON LEY ESTABLISHMENT IN THE PRESENCE OF N

Added P_2O_5 (lb. P_2O_5 per acre)	1951—Mean Annual Yield of Dry Matter	1951—MEANS OF DATA OBTAINED FROM THE 1ST CUT				
		Crude Protein	P_2O_5		CaO	
	(lb. per acre)	(lb. per acre)	(per cent of Dry Matter)	Yield (lb. per acre)	(per cent of Dry Matter)	Yield (lb. per acre)
0	1,321	147	0·51	4·11	1·03	8·03
36	1,881	321	0·57	10·97	0·91	17·52
72	2,038	355	0·60	13·57	0·82	18·55
144	2,217	369	0·67	15·90	0·88	20·89

TABLE II.—EFFECT OF P_2O_5 ON PERMANENT GRASSLAND IN PRESENCE OF N

Added P_2O_5 (lb. P_2O_5 per acre)	1951—Mean Annual Yield of Dry Matter	1951—MEANS OF DATA OBTAINED FROM THE 1ST CUT				
		Crude Protein	P_2O_5		CaO	
	(lb. per acre)	(lb. per acre)	(per cent of Dry Matter)	Yield (lb. per acre)	(per cent of Dry Matter)	Yield (lb. per acre)
0	2,576	374	0·41	15·05	0·69	25·34
36	2,979	446	0·51	22·04	0·76	32·85
72	3,158	557	0·54	29·03	0·77	41·39

TABLE III.—EFFECT OF N ON LEY ESTABLISHMENT IN THE PRESENCE OF P

Added N (lb. N per acre)	1951—Mean Annual Yield of Dry Matter	1951—MEANS OF DATA OBTAINED FROM THE 1ST CUT				
		Crude Protein	P_2O_5		CaO	
	(lb. per acre)	(lb. per acre)	(per cent of Dry Matter)	Yield (lb. per acre)	(per cent of Dry Matter)	Yield (lb. per acre)
0	1,590	227	0·59	8·45	1·04	14·90
30	1,814	278	0·57	9·96	0·88	15·37
60	1,993	285	0·57	11·36	0·87	16·81
120	2,060	405	0·60	13·57	0·83	18·77

Table IV.—Effect of N on Permanent Grassland in the Presence of P

Added N (lb. per acre)	1951—Mean Annual Yield of Dry Matter	1951—Means of Data Obtained from the 1st Cut				
		Crude Protein	P_2O_5		CaO	
	(lb. per acre)	(lb. per acre)	(per cent of Dry Matter)	Yield (lb. per acre)	(per cent of Dry Matter)	Yield (lb. per acre)
0	1,747	283	0·51	14·28	0·75	21·00
15	2,195	369	0·49	18·76	0·73	27·95
30	2,665	439	0·49	21·29	0·72	31·28
60	3,248	436	0·47	21·26	0·78	35·28
90	3,718	610	0·46	26·37	0·69	39·56
120	3,875	737	0·48	30·42	0·76	48·17

Table V.—Relationship Between pH and Response to P in Permanent Grassland

pH	Control Yield (tons per acre) fresh material	Added P	
		P36–Po	P72–Po
6·66	3·69	0·18	0·18
6·54	3·12	−0·16	0·01
6·34	5·95	1·13	1·71
6·27	3·00	0·18	0·16
5·95	2·21	0·77	1·29
5·86	2·82	1·75	2·10
5·82	5·18	0·62	0·39
5·66	7·60	0·07	0·62
5·59	9·57	0·86	1·45
5·50	3·65	1·36	1·57
5·35	4·24	1·37	0·95
5·11	5·85	2·39	2·55

P36–Po : r = −0·8298, significance 0·001, regression coefficient −1·066

P72–Po : r = −0·587, significance 0·05, regression coefficient −0·997

Table VI.—Relationship Between pH and Uptake of P_2O_5 in Permanent Grassland Herbage

pH	P_2O_5 (per cent of Dry Matter)	
	P36–Po	P72–Po
5·41	0·20	0·28
5·44	0·17	0·27
5·64	0·14	0·21
5·95	0·14	0·29
6·37	0·09	−0·13

Table VII.—Relationship Between Added N and pH

Added N (lb. N per acre)	pH	
	Leys	Permanent Grassland*
0	5·49	5·85
15	—	5·84
30	5·47	5·76
60	5·43	5·66
90	—	5·62
120	5·38	5·55

*Permanent grassland had received 3 dressings of N at these rates.

Table VIII.—Relationship Between Rainfall and Response to P in Ley Establishment and Permanent Grassland

Rainfall (during month prior to cutting)	Response to Added P	
	P36–Po	P72–Po
	(tons fresh material per acre)	
Leys—		
5·06	4·17	6·31
4·79	5·75	6·07
4·71	3·61	6·08
3·91	2·12	4·21
3·74	3·26	4·90
3·63	3·28	4·56
3·18	3·41	4·70
3·15	4·42	6·17
2·45	2·41	5·09
2·43	0·73	1·77
1·63	1·09	1·45
1·41	0·56	1·36
Permanent Grassland—		
6·50	1·13	1·71
4·48	1·36	1·57
3·52	1·37	0·95
2·89	0·07	0·64
2·28	0·77	1·29
1·92	0·18	0·18
1·87	−0·01	0·01

Leys:

P36–Po, r=0·798, significance 0·01, regression coefficient 1·05

P72–Po, r= 0·832, significance 0·001, regression coefficient 1·29

Permanent Grassland:

P36–Po, r=0·687, significance 0·10, regression coefficient 0·25

P72–Po, r=0·805, significance 0·02, regression coefficient 0·32

TABLE IX.—RELATIONSHIP BETWEEN RAINFALL AND RESPONSE TO N IN LEY ESTABLISHMENT

Rainfall (during month prior to cutting)	Response to Added N (lb. N per acre)			
	0	30	60	120
	(tons fresh material per acre)			
5·06	6·02	7·24	7·84	7·41
4·79	5·90	7·14	7·65	9·59
4·71	2·74	4·06	6·04	6·53
3·74	3·76	4·47	5·18	6·35
3·63	3·98	6·04	6·72	6·86
3·18	5·60	6·32	5·41	4·56
3·15	3·60	4·23	5·09	5·07
2·45	2·16	3·87	4·54	5·35
2·43	1·98	1·92	2·08	1·01
1·63	1·82	1·81	1·67	1·15
1·41	1·34	2·24	2·15	1·96

Added N (lb. N per acre)	r	Sign.	Regression coefficient
0	0·763	0·01	1·029
30	0·805	0·01	1·291
60	0·919	0·001	1·606
120	0·877	0·001	1·928

THE DEVELOPMENT OF FEEDING STANDARDS FOR CATTLE

By M. H. French, Joint Animal Industry Division, E.A. Agriculture and Forestry Research Organization and E.A. Veterinary Research Organization

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At the end of the 17th century autumn slaughtering was the traditional practice in Europe because farmers were then unable to feed many stock through the winter. Consequently, livestock quality remained poor and improvement was practically impossible until such time as the enclosures gave farmers the assurance that their fodder crops would be reserved for their own stock and not be consumed by their neighbours' communally grazed animals. Once systems were devised for growing fodder crops and conserving them for winter use, improvements in size, early maturity and productivity of cattle automatically became possible. During the 18th century, when cattle weights at Smithfield were doubled, the need arose for better systems of feeding and for more knowledge on economic methods of rationing. In particular, farmers wished to know the "replacement" values of feeding-stuffs so that, if one component of the diet became unavailable, it could be replaced by another without affecting the productivity of the ration.

In fact, there is some analogy between the 18th and early 19th century conditions in Europe and the existing position in East Africa, where there is an urgent need to improve the communally grazed animals in African areas and to make the maximum economic use of livestock on the more intensive European farms. There is the same demand for knowledge on the feeding values of pastures and feeding-stuffs and the same search for information on the economics of feeding and the possibilities of replacing unavailable by available foodstuffs. Just as in Europe, where maximum economy in feeding was impossible without a knowledge of the nutrient requirements of cattle, so in East Africa, a knowledge of feeding values cannot be fully utilized, except in conjunction with the nutrient requirements of the different types of cattle and their products.

In East Africa, no determinations of the minimum nutritive requirements of indigenous cattle have yet been made, and the requirements of pure and high-grade European animals have been deduced from data obtained in temperate environments. Unfortunately the units employed in defining feeding standards and for measuring the nutritive values of feeding-stuffs overseas vary according to the authority consulted. The result is that one farmer may be using the total digestible nutrient (T.D.N.) system of the U.S.A., another may be working with Scandinavian food or production units, whilst a third may be dealing with European starch equivalents (S.E.) and digestible protein (D.P.) or protein equivalents (P.E.). The same is true for advisory officers, and difficulties occasionally arise through the use of the different systems. To help remove such confusion, the historical development of the different rationing systems is described and an attempt made to indicate, by examples, the relationships between the different systems and units.

Feeding standards are statements of the food or nutrient requirements of animals, of different weights and types for different purposes, such as maintenance and the production of milk, fat, etc. Their development occurred in five steps, varying in accuracy and efficiency with the scientific facilities, knowledge and thought of the times. The first step was to assess mutual replacement values, based on contents of soluble extractives, and to link these with animal requirements by using hay as a standard of reference. The second step evaluated feeding-stuffs on the basis of their crude chemical composition, and animal requirements were stated in the same units. In the third step, digestible nutrients were used for evaluating foodstuffs, and feeding standards for "average" animals were expressed in the same terms. The fourth step sought to relate more specifically the productivity from livestock with the consumption of food nutrients and, in this phase, the "food unit" system was evolved from the results of practical feeding trials. During the same period, the scientific basis was laid for all future work when it was recognized that feed supplies had first to meet the maintenance requirements of stock before surplus nutrients could be used for productive purposes. The fifth step was an elaboration of the fourth in that more accurate estimates of animal requirements were made and data was accumulated which permitted rationing to take into consideration not only the different types of animals but the quality, as well as the nature and quantity, of their products.

Historical Development of Feeding Values and Standards

In the first quarter of the 19th century, Davy determined the relative feeding values of different feeding-stuffs by estimating their contents of water soluble matter. He considered certain solubles represented "really nutritive" substances, e.g. gums, starches, sugars and albumen, and that, by adding these extractives together, the total nutritive value could be obtained and expressed as a fraction of that of "Norfolk barley". The errors of this work were in assuming that animals extracted nutritive substances equally easily from all feeding-stuffs and that water-insoluble fibres and fats had no feeding values.

Thaer, with the help of his chemical colleague, Einhoff, tackled the same problem independently. Einhoff extracted feeding-stuffs with water, alcohol, acids and alkalis, and Thaer calculated nutritive values by adding together the extracted ingredients—gluten, starch and mucilaginous sugar. He proceeded (1809) to calculate tables of "hay equivalents" which expressed feeding values in terms of the weight of feeding-stuff which contained the same quantity of soluble matter as 100 lb. of good hay. Since it was known from practical experience what quantity of hay was needed for a given type of stock and production, it was assumed that it would be possible to calculate, from the "hay equivalents", what quantity of a given feeding-stuff, when fed instead of hay, would give a comparable production. Thaer's "hay equivalents" were rapidly adopted in Europe because it was then not realized how unsound it was to estimate feeding values by Einhoff's methods, to compare concentrates with roughages and to employ as the reference standard such a variable foodstuff as hay.

Boussingault, in 1836, biased by his own work on the role of nitrogen in leguminous plants and impressed by the work of Magendie and others on the value of nitrogen in animal nutrition, constructed a new table of "hay equivalents" based on laboratory nitrogen determinations. Boussingault merits recognition as the first to test his deductions by liveweight studies on animals fed rations in which one component was replaced by the calculated equivalent of another feeding-stuff. As a result of these animal tests, Boussingault modified his view and admitted that although the nitrogenous portions of the diet were the most important, starches, sugars, gums and oils were indispensable auxiliaries. He considered fibre contributed nothing to nutritive values.

Liebig, in 1842, recognized the importance of both the nitrogenous and non-nitrogenous constituents of a food. The former he considered necessary for meat and milk production and the latter for producing heat. Liebig, however, did not believe that fibre played any part in nutritive values.

Lawes and Gilbert, from 1852, showed that carbohydrates formed fat, as well as heat, in the animal, thus disproving the widely held hypothesis that the efficiency of a feeding-stuff, for producing liveweight increase, depended on its nitrogen content. Continental workers took a renewed interest in nutrition and the Rothamsted results were taken a stage further by Voit, who confirmed in 1869 that nitrogen excretion paralleled intake and indicated how intake of nitrogenous constituents, surplus to flesh- and milk-forming needs, was katabolized in the body and used to supply energy for heat or work. Pettenkofer and Voit (1873) proved that body fat could be formed from food protein and food fat, whilst Henneberg's results were shown by Wolff (1879) to prove that food carbohydrate could be converted into body fat.

Grouven, in 1858, broke away from the "hay equivalent" system and drew up tables of nutritive values based on the contents of crude protein, fat and carbohydrates. He developed feeding standards for different types of livestock, which prescribed certain quantities of crude nutrients in a given dry matter bulk for different liveweights. He also suggested that rations should contain appropriate minerals. Such standards, it is now realized, were inadequate because they did not take into consideration the fibre constituents nor allow for the indigestible portions of the crude nutrients.

In 1860, Henneberg demonstrated, by controlled animal experiments, that systems of feeding based on Thaer's "hay equivalents" were untenable. Henneberg and Stohmann, by applying the newer knowledge of physiology to herbivorous nutrition, inaugurated a system of comparing feeding-stuffs which has lasted, with slight modifications, to the present day. They determined the digestibilities of the different nutrients in feeding-stuffs and expressed feeding values in terms of the digestible nutrient contents.

Wolff, who had been trying to correct Thaer's "hay equivalents" by taking into consideration the crude fibre component, abandoned this attempt when Henneberg and Stohmann's estimates of digestible nutrients became known in 1864. He made, instead, a comprehensive study of existing records of feeding trials with dairy cows and, in 1874, expressed the nutritive requirements of cows in terms of digestible nutrients. Wolff's standard was intended to apply to all "average" cows although, from his text, it applied specifically to the 1,000 lb. cow yielding 20 lb. milk.

The Wolff feeding standards received wide attention in Europe and America and formed the basis from which many modern standards, such as the Wolff-Lehmann, Haecker, Savage and the Morrison computations, have been developed. The original Wolff standards, however, were not sufficiently flexible to meet the variations in feeding-stuffs, livestock and levels of production and did not take into consideration the quantity of milk produced.

J. Kühn, in 1887, prepared the way for the next and more scientific basis of rationing by distinguishing between that portion of a ration which was necessary to keep an animal alive, in health and at constant weight, i.e. the maintenance ration, and the food nutrients which were available in excess of maintenance requirements and which were the only nutrients available for productive purposes. By breaking the total requirements of a cow into maintenance and production requirements, the definition of feeding standards became sufficiently elastic to cater for all sizes of cows and for all levels of milk production. It is interesting to note that this method of rationing has persisted to the present day, and although it is the only basis on which rations can be balanced scientifically to secure maximum production, it was evolved in order to secure optimum economic production.

In addition to making his contributions to the principles of rationing, G. Kühn initiated a series of calorimetric and balance studies which were continued after his death by Kellner. From these studies, Kellner developed a system of evaluating the nutritive value of foodstuffs and expressing feeding standards, based on digestible protein and starch equivalent values, which is still being used. Kellner first determined how much fat was produced in a bullock in store condition, from the feeding of starch. He then determined the fat-producing values of the other organic nutrients, when fed as such or in the form of a feeding-stuff. He thus compared feeding-stuffs on the basis of the fat they could produce in a store ox. Knowing the fat produced by a pound of starch, he converted his fat-producing values into starch equivalents or the weight of starch which would produce the same quantity of fat in store oxen as 100 lb. of feeding-stuff. In 1900, he abandoned the system of expressing feeding standards in terms of digestible nutrients in favour of his new system. In introducing this change, he was influenced by the realization that the fat produced from a given quantity of starch equivalent or food nutrients was not an invariable constant but differed between individual animals. He considered that a comparative rather than an absolute value should be adopted. Although Kellner's Starch Equivalents have been widely and successfully used for calculating maintenance and milk-producing values, their use for these purposes has stretched their original meaning rather unduly.

Working independently of Kellner, Armsby in U.S.A. determined calorimetrically the productive values of feeding-stuffs but expressed them in terms of net energy. In effect, net energy or the net calories available to the animal from a given quantity of foodstuff, is essentially the same measure of nutritive value as Kellner's Starch Equivalent. Since starch has a constant energy value, Kellner was able to convert his fat gains into calories and re-convert these into Starch Equivalents. He felt that feeding values and standards in terms of pounds of starch would be more easily understood in practice than a figure representing the same net energy value.

The original Wolff standards stated the requirements of digestible nutrients for a "standard" cow yielding an "average" amount of milk. The modified Wolff-Lehmann standards, published in 1897 following the lead given by Kühn, expressed the cow's requirements in terms of maintenance and the nutrients per gallon of "average" milk. The next step followed the publication by Haecker, in 1914, of data showing how the nutrient requirements varied with the composition of milk. Later feeding standards, such as the Woll-Humphrey, Savage or Morrison calculations, have attempted further simplification in that, instead of using a number of figures to represent the requirements of each digestible nutrient, a single equivalent term, total digestible nutrients, has been employed.

In contrast to the above methods of determining feeding standards from chemical and physiological studies, Fjord, in 1872, started a series of practical feeding experiments in which the replacement values of different feeding-stuffs were studied by direct observations on the productivity of pigs and cows. This study was continued, after Fjord's death, by Hansson and others, and has led to the Scandinavian system based on "food units". This is a resuscitation of Thaer's "hay equivalents" system but is based on barley equivalents (i.e. a concentrate food less subject to variation than hay), and one "food unit" represents the nutritive value of one kg. barley. Hansson developed this system by preparing standards for maintenance and milk production in terms of digestible protein and food units.

Later, Mollgaard introduced a modified system using as a production unit the net energy for fattening which will yield 1,000 Cal. milk energy, i.e. 837 Cal. in a ration properly balanced for protein.

Glossary of Terms

Before attempting to compare feeding standards or the nutritive value of feeding-stuffs by the different systems in use to-day, it is advisable to clarify the various terms employed.

Crude protein represents the total nitrogen multiplied by 6.25, or the quantity of protein which would be present if all the nitrogen were in the form of protein. Actually, only part of the nitrogen present is combined into proteins (i.e. the true protein) and part, usually only a small part, is in the form of other nitrogenous compounds. These non-protein bodies are generally grouped together as "Amides", so that:

Crude protein = true protein plus "Amides".

In common with other nutrients, the quantity of crude protein, in a foodstuff, as estimated by chemical means, does not represent the feeding value since it is only the digested portions which can possibly be of value to the animal. Hence digestible crude protein = digestible true protein plus digestible "Amides". It is normally accepted that digestible "Amides" have a biological value to the animal equal to half that which they would possess if all their nitrogen were in the form of true protein. To allow for this, some authorities make use of the term "protein equivalent" in which—

Protein Equivalent (P.E.) = Digestible true protein plus $\frac{1}{2}$ digestible "Amides".

= Digestible true protein plus $\frac{1}{2}$ (digestible crude protein —digestible true protein)

= $\frac{1}{2}$ (digestible crude protein plus digestible true protein)

Turning now to the terms used in measuring the non-nitrogenous nutrients of feeding-stuffs:—

Gross Energy is the total energy contained in, or released in the form of heat when a foodstuff is burned completely.

Metabolizable Energy (M.E.) is that portion of the Gross Energy which is capable of transformation within the body. It represents gross energy minus the energy in the excreta (fæces, urine and combustible gases).

Net Energy (N.E.) represents the energy of a feeding-stuff which is actually available for use by or storage in the body. Energy is lost to the body during the digestion and assimilation of a foodstuff and this energy escapes from the body as heat. Thus net energy = metabolizable energy minus the heat lost from the body.

Starch Equivalent (S.E.) as already explained measures the fat-producing value of a foodstuff expressed in terms of the weight of starch that would produce the same quantity of fat in an ox, as 100 lb. of the foodstuff. It is substantially the same as net energy and is now used in the same way as net energy for maintenance and milk production calculations. For fattening purposes 1 lb. S.E. = 1,071 Cal. N.E.

Total Digestible Nutrients (T.D.N.) is the sum of the digestible crude protein plus digestible carbohydrates plus digestible crude fibre plus (2.25 × digestible fats). Actually it is a measure of gross energy minus the energy of the fæces and exceeds the metabolizable energy by the energy value of the urine plus combustible gases. Since the energy in the urine and combustible gases is small in comparison with the energy in the fæces, the T.D.N. value is an approximate measure of metabolizable energy.

Food Unit (F.U.) is the weight of a foodstuff which can replace 1 kg. barley in a ration without altering the productivity of the diet, i.e. the barley equivalent.

Production Unit (P.U.) is the net energy for fattening which will produce 1,000 Cal. of milk energy. Whereas the above systems require a statement of the digestible protein requirements as well as N.E., S.E., T.D.N., or F.U., this system attempts to ensure an adequacy of protein by incorporating a minimum amount of protein energy in the total net energy value.

Systems of Calculating Nutritive Values

It may appear, from the foregoing, that considerable differences exist between the various units for defining feeding standards or for measuring feeding values. For example, in Table I are a randomly chosen selection of feeding values published by several authorities. The figures have been converted to a dry matter basis to remove variations due to differing water contents, but otherwise indicate the apparent variation in feeding values due to the different systems of evaluation when imposed on the differences due to seasons, locality and the discrepancies between the animals used by the various evaluators.

From Table I it is seen that the total digestible nutrient values, except for oil-seeds, are always numerically greater than starch equivalent values and the difference increases as the fibre content rises. The greatest similarity between T.D.N. and S.E. figures is found in the cereal and leguminous grains. Net energy numerical values usually lie between T.D.N. and S.E. figures, but, like the S.E. values, the greatest difference between T.D.N. and N.E. occurs with the more fibrous foodstuffs. Food unit figures, whilst generally higher than other estimates of nutritive values, are again lower than T.D.N. values for fibrous fodders.

To remove the differences due to variations in foodstuffs, grown and examined in different countries, and to eliminate differences arising from varying digestibilities, Table II has been constructed. The compositions and digestibilities of the foodstuffs used therein are those reported by Henry and Morrison and the T.D.N., S.E. and F.U. values have been calculated from their data. The N.E. figures are taken from Armsby's calculations on this same material, and the estimates of nutritive values (columns 4–7) show how the numerical estimates differ according to the system employed in their evaluation.

Table II again shows the greater numerical value of T.D.N. over S.E. estimates and the widening of this difference with the more fibrous nature of the foodstuffs being compared. Of the 25 comparisons in this table, N.E. figures exceed T.D.N. values in 24 per cent of the cases; lies between T.D.N. and S.E. values in 60 per cent of the comparisons and is below both T.D.N. and S.E. in 16 per cent of the foodstuffs. The estimate of food units numerically exceeds all other figures in 77 per cent of the comparisons, but in the remaining fibrous foods it falls below T.D.N. values.

In order to take these comparisons a stage further, the figures in Table II have been converted into net energy values both for fattening and for milk production. To obtain the N.E. equivalents for fattening (columns 8–10), Kellner's estimate of 1,071 Cal. per lb. of starch equivalent and Hansson's figure of 750 Cal./lb. of food unit have been employed. Since the T.D.N. values are rough estimates of metabolizable energy, their conversion into N.E. equivalents is less easy, because of the variable heat losses between foodstuffs and between animals, due to differing planes of nutrition and the purposes for which the nutrients are used as well as the manner in which heat losses are affected by the nature and amount of the other foodstuffs in the ration. In constructing column 8, use has been made of Armsby's metabolizable energy equivalents for the different foodstuffs, together with the estimate, of the Pennsylvania Animal Nutrition Institute, that 1,000 Cal. metabolizable energy are equivalent on an average to 575 Cal. N.E. for fattening.

When compared in this way and with Armsby's N.E. figures in column 6, the different systems agree fairly well for grains and succulent fodders. The T.D.N. equivalent is higher than the other estimates for roots, oily concentrates and fibrous fodders. The N.E.

computations for the S.E. and F.U. fattening equivalents compare satisfactorily.

If a cow is fed above her maintenance requirements, the surplus N.E. can either be converted into milk or into liveweight increase. It has been shown repeatedly that for a given N.E. intake, the energy contained in the milk produced is greater than that which could be stored in the form of liveweight increase. In other words, N.E. is more efficiently utilized for milk production than for producing liveweight gains. For this reason, in columns 11–13 of Table II, the different estimates of nutritive values given in columns 5, 6 and 7 have been computed into the relative net energy values for milk as opposed to fat production. The N.E. figures for milk production have been calculated from T.D.N. by using Armsby's metabolizable energy equivalents in conjunction with the Pennsylvanian estimate, that 69.3 per cent of metabolizable energy is utilized for milk production. The other units have been converted by using Wood's figure of 1,350 Cal. of milk energy from 1 lb. S.E. and Hansson's finding that 1 lb. F.U. produces 923 Cal. as milk.

Obviously, the figures for milk-producing net energy, computed in this manner, exceed Armsby's net energy values. The N.E. equivalents calculated from S.E. values exceed those from the F.U. system for tubers and the non-leguminous fodders, but the reverse is true for the grains, oilseeds, cakes and roots. The net energy, computed from T.D.N. values, exceeds the other calculations for roots and roughages but is lower than those for grains and oilseeds.

It will be seen from the above tables that the various estimates of nutritive values, when converted to their net energy equivalents, are not so discordant as their numerical figures under the T.D.N., S.E., and F.U. systems suggest. In this connexion, it is important to remember that no statements of feeding values or feeding standards are to be accepted as invariable constants. There are so many interfering factors in biological systems that any expressions of feeding values or of nutrient requirements can only be regarded as guides for practical use and should never have attributed to them the inflexibility of constants from the physical sciences.

Feeding Standards

As outlined earlier, feeding standards are statements or estimates of the nutrient requirement of animals of different sizes and for different quantities and qualities of production. They have been established on the basis of a limited number of experiments and consequently, like the estimates of the feeding values, are guides to be used intelligently and not inflexible constants to be followed blindly.

For convenience in demonstrating the comparability of the different systems of evaluating foodstuffs, examples will be confined to cows and milk production, although similar comparisons could be made for ox liveweight gains or for work production. The feeding standards prescribe the nutrients needed for a given level of production and, from tables of feeding values similar to Tables I and II, it is possible to calculate mixtures of different foods which will meet the animal's requirements and be within its capacity to consume. Any attempt to design a balanced ration, *inter alia,* involves juggling with mixtures of foodstuffs until approximately the correct amount of nutrients are being provided. To be able to do this, feeding values and feeding standards must obviously be expressed in the same units and for each of the four systems of foodstuff evaluation, described above, there are four corresponding feeding standards.

Comparison of Feeding Standards

In order to compare the different feeding standards and to be able to use them subsequently for evaluating rations, Table III has been constructed.

Following the teachings of Kühn, dairy standards prescribe the maintenance requirements which must be met and then the varying quantities of nutrients needed for the production of a given weight of milk of a specified butterfat content. In Table III, for simplicity only, the maintenance requirements refer to the 1,000-lb. cow, and the production requirements to 1 gallon of F.C.M. milk (4 per cent B.F.). The following calculations could equally well have been based on cows of a different size and for milk of another fat content provided the corresponding standards of nutrient requirements were employed.

Milk-production Calculations

By taking the corresponding values for feeding-stuffs and for feeding standards, it is instructive to calculate for each of the above systems, the nutritive values of rations and, from these, to estimate the quantity of 4 per cent milk which they could produce. For this purpose, the six food mixtures in Table IV have been chosen and, the feeding values, in columns 4–7, of Table II, have been used in conjunction with the corresponding feeding standards in Table III.

In Table IV, mixtures 1 and 2 are concentrates, for feeding above maintenance requirements for producing milk. For both concentrate mixtures, the T.D.N. system slightly underestimates productivity in comparison with the S.E., N.E., and F.U. computations, all of which agree satisfactorily with each other. For mixture 6, which is composed of fibrous fodders and is only a little above maintenance requirements, the T.D.N. and F.U. systems give slightly higher and the S.E. values slightly lower estimates of productivity than the N.E. units. There is also greater variance in the amount and the nature of the nutrients surplus to milk production than is the case for the concentrate mixtures. In Mixture 3, fibrous fodder is combined with concentrates to give a ration suitable for two-gallon cows and the variability in the nature of nutrients surplus to milk requirements disappears. In this case, the N.E. and F.U. calculations predict higher levels of production than do the T.D.N. and S.E. systems.

Mixtures 4 and 5 are composed entirely of home-grown foodstuffs and are mentioned partly to compare their relative productivities but also to emphasize that satisfactory rations for 1½–2-gallon cows can be designed without the need for concentrates. Mixture 5 indicates how two gallons of milk can be obtained by strip-grazing a green cereal crop, supplemented by ordinary and legume hays. In a good-quality ration of this nature the four systems of calculation give similar estimates of milk yield. When lower-quality forage mixtures are employed, as in Ration 4, there are greater discrepancies in calculated yields and in the nature and quantities of the surplus nutrients.

Thus, although the numerical values of nutritive values may vary between the four common systems in use to-day, these differences disappear to a large extent when the values are employed, in conjunction with the corresponding feeding standards, for calculating the productivity of rations. On the whole, bearing in mind the variations likely to be encountered between animals and between samples of the same foodstuff, the four systems are equally satisfactory for practical use.

BIBLIOGRAPHY

Armsby, H. P.—U.S. Dept. Agric., *Anim. Indust. Buls.* 101 of 1908, and 143 of 1912.

Armsby, H. P.—The Nutrition of Farm Animals, 1928.

Boussingault, J. B.—Economie Rurale, 1843.

Davy, H.—Elements of Agricultural Chemistry, 1813.

Departmental Committee on the Rationing of Dairy Cows. Ministry of Agric. and Fish., H.M.S.O., 1925.

Forbes, E. B., and Kriss, M.—*Proc. Amer. Soc. Anim. Prod.*, 1931, p. 113, and 1932, p. 344.

Grouven, H.—Vorträge über Agriculturchemie, 1858.

Haecker, T. L.—*Minn. Agric. Exp. Stat. Buls.* 79 of 1903 and 140 of 1914.

Hansson, N.—Husdjurens Utfodring, 1922.

Hansson, N.—Fütterung der Haustiere, 1926.

Henneberg, W.—*Landw. Vers. Stat.*, Vol. 10, p. 455, 1868.

Henneberg, W.—Beiträge zu Fütterung der Wiederkäuer, 1860.

Henneberg, W., and Stohmann, F.—Beiträge zu Begründung einer rationeller Fütterung der Wiederkäuer, 1864.

Henry, W. A., and Morrison, F. B.—Feeds and Feeding, 1928.

Kellner, O.—*Landw. Vers. Stat.*, Vol. 53, p. 1, 1900.

Kellner, O.—Ernährung der landwirtschaftlichen Nutztiere, 1905.

Kühn, G.—*Landw. Vers. Stat.*, Vol. 44, p. 257, 1894.

Kühn, J. von.—Die zweckmässigster Ernährung des Rindviehs, 1887.

Lawes, J. B., and Gilbert, J. H.—Rpt. to the British Association, 1852.

Lawes, J. B., and Gilbert, J. H.—*J. Roy. Agric. Soc.*, Vol. 14, 1853.

Lehmann, C.—Mentzel & von Lengenke's Landw. Kalender, 1897–1906.

Liebig, J. von.—Chemie Organique Applicuée à la Physiologie Animale, 1842.

Magendie, F.—*Ann. Chem. Phys.*, Vol. 3, p. 66, 1816.

Mollgaard, H.—Fütterungslehre des milchviehs, 1929.

Pettenkofer, M., and Voit, C.—*Ztschr. Biol.*, Vol. 9, p. 435, 1873.

Savage, E. A.—N.Y. (Cornell) *Agric. Exp. Stat. Bul.* 323, 1912.

Voit, C.—*Ztschr. Biol.*, Vol. 5, p. 79, 1869.

Wolff, E. von.—Landw. Jahrb., Vol. 8, p. 269, 1879.

Wolff, E. von.—Die Landwirtschafliche Fütterungslehre, 1874.

Woll, A. S., and Humphrey, G. C.—*Wis. Agric. Exp. Stat. Res. Bul.* 13 of 1910.

Wood, T. B.—Animal Nutrition, 1927.

Woodman, H. E.—Rations for Livestock, 1952.

TABLE I.—DRY MATTER NUTRITIVE VALUES OF FOODSTUFFS EVALUATED BY DIFFERENT WORKERS

	Morrison's Total Digestible Nutrients	Woodman's Starch Equivalent	Kellner's Starch Equivalent	Hansson's Starch Equivalent	Armsby's Net Energy	Hansson's Food Units
Barley	87.5	83.9	85.9	84.2	99.2	117.3
Oats	77.5	68.6	68.6	69.1	74.4	97.8
Maize	95.9	89.2	94.0	88.5	95.7	122.6
Peas	83.9	80.2	79.8	79.4	86.7	118.7
Beans	83.0	76.8	77.7	77.9	84.6	118.2
Soyabeans	104.4	87.7	93.2	—	90.2	—
Sunflower Seed (with hulls)	104.5	112.3	103.8	—	99.3	—
Cottonseed	88.3	88.4	94.3	—	86.5	—
Cottonseed Cake	84.5	75.8	77.4	79.1	101.1	130.4
Coco-nut Cake	102.4	86.7	85.5	88.2	92.4	131.2
Groundnut Cake	89.4	81.4	83.9	83.2	104.8	139.2
Wheat Bran	67.7	56.3	55.4	53.7	59.0	91.9
Brewers' Grains	71.0	53.8	55.3	55.4	55.5	82.3
Sugar Beet	85.4	64.1	63.2	69.6	68.3	94.0
Mangolds	78.7	51.7	52.5	67.3	60.4	91.8
Turnips	77.9	51.8	54.1	65.9	64.8	90.9
Potatoes	80.7	77.7	78.8	77.2	86.2	104.0
Kale (M. S.)	64.6	64.7	—	—	—	—
Italian Rye Grass	59.4	45.6	45.6	45.6	—	64.0
Green Oats	60.9	43.1	52.8	43.5	53.9	61.6
Green Maize	67.0	46.9	46.9	44.8	65.0	61.0
Oat Silage	61.1	37.6	37.6	—	—	—
Maize Silage	62.5	57.6	46.5	—	60.4	—
Oat Hay	52.7	39.5	39.8	34.8	36.6	40.6
Cynodon Hay	48.1	—	—	—	—	—
Lucerne Hay	56.5	32.3	26.8	37.5	35.0	54.6
Cowpea Hay	54.3	—	—	—	41.6	—
Maize Cobs	53.4	—	24.3	—	—	—
Maize Stover	56.9	—	23.9	—	39.0	—
Oat Straw	51.5	23.3	19.8	22.1	39.3	29.5
Wheat	40.3	15.1	19.5	16.9	7.9	22.7

TABLE II.—NUTRITIVE VALUES AND COMPARATIVE NET ENERGY EQUIVALENTS

	1	2	3	4	5	6	7	8	9	10	11	12	13
	Dry Matter	Dig. Crude Protein	Dig. True Protein	Total Dig. Nuts	Starch Equiv.	Net Energy	Food Units	Net Energy Equivalents for fattening			Net Energy Equivalents for Milk Production		
								T.D.N.	S.E.	F.U.	T.D.N.	S.E.	F.U.
Barley	90.7	9.0	8.3	79.4	77.9	89.9	109.6	80.8	83.4	82.2	97.3	105.2	104.6
Oats	90.8	9.7	8.7	70.4	65.8	67.6	93.8	71.7	70.7	70.3	86.3	88.8	89.5
Maize	87.8	7.7	7.2	84.2	83.1	84.0	110.0	85.7	89.0	82.5	103.2	112.2	105.0
Peas	90.8	19.0	16.6	76.2	73.4	78.7	110.1	77.5	78.6	82.6	93.4	99.1	105.1
Beans	86.6	18.8	16.4	71.9	68.6	73.3	103.3	73.1	73.4	77.5	88.1	92.6	98.6
Soyabeans ..	90.1	33.2	27.3	94.1	87.3	81.3	137.6	98.1	93.5	103.2	118.3	117.8	131.4
Sunflower Seeds (with hulls) ..	93.1	13.5	11.7	97.3	91.7	92.5	130.5	101.5	98.2	97.9	122.3	123.8	124.6
Cottonseed ..	90.6	13.3	11.9	80.0	77.0	78.3	110.8	83.4	82.5	83.1	98.3	103.9	105.8
Cottonseed Cake..	92.5	37.0	35.4	78.2	75.0	93.5	123.4	89.9	80.3	92.5	108.4	101.2	117.8
Coco-nut Cake ..	92.3	18.4	18.0	94.5	96.1	100.3	126.8	108.7	102.9	95.1	131.0	129.7	121.0
Groundnut Cake..	93.4	40.3	—	83.5	80.9	ND	133.3	96.0	86.6	100.0	115.7	109.2	127.2
Wheat Bran ..	89.9	12.5	10.8	60.9	47.2	53.0	80.7	61.9	50.6	60.5	74.7	63.7	77.0
Brewers' Grains ..	92.5	21.5	20.2	65.7	53.5	53.4	83.1	68.5	57.2	62.3	80.5	72.2	79.3
Sugar Beet ..	16.4	1.2	0.4	14.0	10.4	11.2	15.9	14.2	11.1	11.9	17.2	14.0	15.2
Mangolds ..	9.4	0.8	0.1	7.4	5.4	5.7	7.6	7.5	5.8	5.7	9.1	7.3	7.3
Turnips	9.5	1.0	0.4	7.4	5.6	6.2	8.0	7.5	6.0	6.0	9.1	7.6	7.6
Potatoes	21.2	1.0	0.1	17.1	17.0	18.3	21.4	17.4	18.2	12.8	21.0	22.9	20.4
Kale	11.3	1.9	—	7.3	6.5	ND	9.8	6.7	7.0	7.3	8.0	8.8	9.4
Italian Rye Grass..	27.1	1.8	—	16.1	14.6	ND	18.8	14.7	15.6	14.1	17.7	19.7	17.9
Green Oats ..	26.1	2.3	2.0	15.9	13.7	14.1	17.1	14.2	14.7	12.8	17.5	18.5	16.3
Green Maize ..	10.6	0.9	0.7	7.1	5.7	6.9	8.1	6.5	6.2	6.1	7.8	7.7	7.7
Oat Silage.. ..	28.3	1.5	—	17.3	12.6	ND	17.0	15.8	13.5	12.8	19.0	17.0	16.2
Maize Silage ..	26.3	1.1	0.6	17.7	15.2	15.9	20.0	16.2	16.3	15.0	19.5	20.5	19.1
Oat Hay	88.0	4.5	3.9	46.4	29.2	32.3	41.4	42.4	31.3	31.0	51.0	39.4	39.5
Cynodon Hay ..	90.3	3.7	—	43.4	28.1	ND	38.2	39.6	30.1	28.6	47.7	37.9	36.5
Lucerne Hay ..	91.4	10.6	7.1	51.6	35.3	34.2	53.6	47.1	37.8	40.2	56.8	47.6	51.2
Cowpea Hay ..	90.3	13.1	9.2	49.0	34.9	37.6	55.0	44.7	37.4	41.2	53.9	47.1	52.5
Maize Cobs ..	90.0	0.4	—	48.1	29.6	ND	39.7	43.9	31.7	29.8	52.9	40.0	37.9
Maize Stover ..	81.0	2.1	1.6	46.1	29.6	31.6	41.0	42.1	31.7	30.8	50.7	40.0	39.1
Oat Straw ..	88.5	1.0	0.8	45.6	24.2	34.8	29.3	41.6	25.9	22.0	50.1	32.7	28.0
Wheat Straw ..	91.6	0.7	0.3	36.9	15.0	7.2	21.2	33.7	16.1	15.9	40.6	20.2	20.2

TABLE III.—REQUIREMENTS FOR MAINTENANCE OF 1,000 LB. COWS AND THE PRODUCTION OF MILK OF 4 PER CENT B.F. CONTENT

Authority	Dry Matter	MAINTENANCE REQUIREMENTS		REQUIRED PER GALLON OF 4% MILK	
		Energy Required	Protein Required	Energy Required	Protein Required
Armsby	20–30 lb.	6.00 Therms	0.50 lb. D.T.P.	2,650 Cal. N.E.	0.49 lb. D.T.P.
Ministry of Agriculture and Fisheries Committee (1925)	20–30 lb.	6.00 lb. S.E.	0.60 lb. D.C.P.	2.60 lb. S.E.	0.63 lb. D.C.P.
Hansson	16.5–23 lb.	7.20 lb. F.U.	0.50 lb. D.C.P.	3.70 lb. F.U.	0.45 lb. D.C.P.
Morrison	15–30 lb.	7.925 lb. T.D.N.	0.70 lb. D.C.P.	3.11–3.46 lb. T.D.N.	0.54–0.65 lb. D.C.P.

TABLE IV.—THE COMPARATIVE PRODUCTIVITY OF RATIONS CALCULATED FROM THE DIFFERENT STANDARDS

Mixture No.	Type of Rationing	Composition of Ration	Total Digestible Nutrient System	Starch Equivalent System	Net Energy System	Food Unit System
1 ..	Milk Production Concentrate	1 lb. Maize Meal 1¼ lb. Oat Meal 1¼ lb. Cotton-seed Cake	0.83 gal. plus 0.162 lb. D.C.P.	1.00 gal. plus 0.036 lb. D.C.P.	1.08 gal. plus 0.096 lb. D.T.P.	1.03 gal. plus 0.20 lb. D.C.P.
2 ..	Milk Production Concentrate	1 lb. Brewers' Grains 1 lb. Coco-nut Cake 1 lb. Peameal ½ lb. Maize meal	0.86 gal. plus 0.11 lb. D.C.P.	1.00 gal. plus 0.05 lb. S.E.	1.04 gal. plus 0.07 lb. D.T.P.	1.01 gal. plus 0.17 lb. D.C.P.
3 ..	Home Grown Fodder and Milk Concentrate	10 lb. Hay 10 lb. Maize Stover 7 lb. Milk Production Concentrate No. 1	Maintenance and 2.00 gal.	Maintenance and 1.90 gal. plus 0.10 lb. D.P.	Maintenance and 2.22 gal.	Maintenance and 2.25 gal. plus 0.39 lb. D.C.P.
4 ..	Home Grown Production Ration	30 lb. Maize Silage 10 lb. Oat Hay 8 lb. Lucerne Hay	Maintenance and 1.64 gal. plus 0.84 lb. T.D.N.	Maintenance and 1.60 gal. plus 0.14 lb. S.E.	Maintenance and 1.30 gal. plus 1.30 Therms N.E.	Maintenance and 1.95 gal. plus 0.22 lb. D.C.P.
5 ..	Home Grown Production Ration	50 lb. Green Oats 7 lb. Lucerne Hay 7 lb. Hay	Maintenance and 2.06 gal. plus 0.21 lb. D.C.P.	Maintenance and 2.04 gal. plus 0.27 lb. D.C.P.	Maintenance and 2.09 gal. plus 0.17 lb. D.T.P.	Maintenance and 2.10 gal. plus 0.81 lb. D.C.P.
6 ..	Home Grown Ration for poor milkers	10 lb. Hay 10 lb. Oat Straw 4 lb. Lucerne Hay	Maintenance and 0.36 gal. plus 1.87 lb. T.D.N.	Maintenance and 0.24 gal. plus 0.14 lb. D.C.P.	Maintenance and 0.30 gal. plus 1.07 Therms N.E.	Maintenance and 0.37 gal. plus 0.22 lb. D.C.P.

A NOTE ON THE BIOLOGY OF CALIDEA DREGEI GERM

By J. C. Duerden and A. C. Evans, Overseas Food Corporation, Tanganyika

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Calidea dregei is well known as a stainer of cotton. Severe infestations of this pentatomid occurred on experimental plots of sorghum and sunflower at Kongwa in 1948 and, in 1949, at Urambo, large-scale plantings of sunflowers also suffered severely. It was clear that *C. dregei* would become a major pest of these crops and investigations were begun on its life-history, effect on the crop and control.

Bionomics

At Kongwa in 1948, adults were first seen on developing heads of sorghum and sunflower in March. By April the females were ready for egg laying but did not lay their eggs on these crops. Search in the neighbourhood revealed numerous nymphs on *Hibiscus* sp. (probably *mastersianus*) only. The new generation of adults appeared in June. They left *Hibiscus* almost immediately and flew to late-planted sunflower chiefly but were observed on the development pods of legumes, castor oil, cotton, safflower and a number of seeds. Adults of both sexes were observed to produce well developed, fat bodies and no ovarial development occurred. This was evidently in preparation for a resting period but no evidence as to where this resting period occurred was found during the dry season, May–December.

In 1949, adults were observed by a colleague on some shrubs between Sagara and Kibumbuni on 4th January. They were later found feeding and mating on a hill to the south of Kongwa on 14th January. By the middle of March adults were present on sunflower heads on the production areas and were numerous by the end of the month. Whether these adults had æstivated during the dry season or whether they were adults of a new generation is not known. The life cycle from egg to adult occupies nearly two months, so it is just possible that they did belong to a new generation bred in the bush. The first nymphs were seen on sunflowers on 8th April. Eggs continued to be produced for about a month and numbers of newly-hatched nymphs were noted on 13th May.

Counts of adults and eggs were carried out on two fields of sunflowers in mid-April; 11,000 and 5,000 adults, and 8,500 and 200 eggs per acre were recorded. The eggs were found in batches between the florets. On a sorghum experiment on the experimental farm a population of 18,000 adults and 800 eggs per acre was estimated. The average number of eggs per batch was 28. They were usually laid in a series of closely apposed rings around a stalk or dried-up leaf. The egg production was low for such a high population but conditions were evidently unsuitable since in some cases the partly developed young in the eggs had died of desiccation and very few nymphs were observed later.

A number of egg batches were bagged on suitable heads of sorghum on 14th April. By 21st April a number had hatched and adults were present on 10th June, giving a nymphal development period of about 50 days.

Small numbers of *C. dregei* adults were seen copulating from the end of December, 1949, on into January, 1950. Eggs were laid usually after about eight days but egg laying has been observed at any time between five and eleven days after copulation. The eggs are normally placed on some part of the plant on which the female has completed her development, often the remnants of, or volunteers arising from, the previous season's crop. Alternatively, eggs may be deposited on wild plants or, when the females are confined in an insectary, on any surface which is available, the wire gauze sides being used on several occasions.

The number of eggs deposited in those egg masses which have been observed varies from 12 to 39 with an average of 28. The eggs are spherical and colourless at first and then turn gradually to a deep red as the embryo develops. The mean percentage emergence when the egg masses are kept in ventilated jars at outside shade temperatures is 67 per cent, some being as low as 31 per cent and others giving complete emergence. Under these conditions the incubation period varies from seven to eleven days, most nymphs emerging nine days after laying. The first stage nymphs are hemispherical in shape and bright red in colour. They become progressively more elongate and acquire a blue colouring which increases with each successive moult.

Five moults occur before the adult form is reached. Observations starting with over 200 nymphs in culture gave the following average number of days between each moult:—

	Days	Extremes
From hatching to first moult ..	6	4–9
From 1st hatching to 2nd moult..	6	5–8
From 2nd hatching to 3rd moult..	8	5–17
From 3rd hatching to 4th moult..	11	7–15
From 4th hatching to 5th moult..	17	10–20

This gives an average period of about 57 days from egg laying to the adult moult and a probable complete cycle from adult to adult of little over 80 days.

C. dregei has been found in all stages of development throughout the year, but probably three main generations are produced in a year. The first and second generations conform broadly to the life cycle outlined above with a third generation having a greatly extended development continuing through the dry season and providing the carry-over of the pest from one year to the next. Accordingly the generations may be represented thus—

1. Jan.—Feb.—March—April,
2. March—April—May—June—July,
3. June—July—Dec.

The nymphs found during June to October inclusive, were in the fourth or fifth instar.

At the end of the dry season small numbers of *C. dregei* were seen on such green plant material as was available. With the first showers in late November and early December sorghum stubbles begin regeneration and the resultant green shoots together with two indigenous plants, *Crotolaria laburnifolia* and *Solanum panduræformæ*, provide preliminary hosts for the pest.

From the middle of January onwards other plants become important as hosts, notably volunteer sunflowers and sunnhemp together with a wild species, *Combretum longispicatum*. It is on these two sets of plants, which provide the early foliage of the season, that the large build-up of the pest takes place. This build-up continues on planted crops, particularly sorghum and sunflower, throughout February and March, until in late March and early April large numbers of adult bugs are present on the young heads of the crop. In approximately 20 days covered by this period the equivalent of nearly 126,000 bugs per acre were removed from an experimental plot of sorghum. In another count 120,000 per acre were collected from a sorghum variety trial between 18th March and 21st April. In the latter case the plant population was approximately 29,500 plants per acre.

From early March onwards comparable numbers of bugs appear on cotton plots no matter how small or remote are such plots. The initial large-scale infestation comes towards the end of the flowering period of the plant as a whole, that is when the lower bolls are swelling rapidly and the bolls on the middle parts of the plant are still fairly small. At this stage *C. dregei* is associated with various species of *Dysdercus* forming a complex of stainers. *Calidea* persists through to the first picking of the lower bolls or even later, feeding for the most part on the late bolls at the top of the plant.

When feeding on sorghums the bug appears to prefer the seeds when in the "milky" stage, that is before the grain becomes hardened with advancing maturity. Accordingly, later-planted sorghum crops are attacked during May and June by the second and probably early individuals from the third generation almost up to harvest.

A comparable development appears to take place in the natural bush, although the number of insects involved is very much smaller. In dense thicket over a mile from the nearest small patch of native-cultivated land adults and nymphs in all stages of development have been found in early March on numerous wild species of bushes. Adults and nymphs have been observed up to the end of June in considerable numbers away from cultivated land in a diversity of habitats ranging from open grassland to dense thicket.

On cultivated land as crop maturity is reached and harvesting takes place the bugs move to any plant which remains green and succulent, although large numbers are destroyed during combining operations on sorghum and sunflower crops. At this time any very late or perennial type crops such as castor provide food for the pest. Natural fallow and regenerated bush together with uncultivated field boundaries and contour banks provide much green plant material well into the dry season. The most favoured plants on these sites are *H. marstersianus* and *S. panduræformæ* with *Astrochlæna hyoscyamoides, Euphorbia spinescens, E. systyloides* and a species of *Comiphera* attracting smaller numbers of bugs. A more extensive host plant list is given below.

Gradually the number of food plant species diminishes until from late October only relatively few *Calidea* persist. These are found principally on castor, both the giant perennial and the dwarf semi-annual types, and Manyara (*Euphorbia Tirucalli*) hedges which remain green throughout the year round houses and gardens.

At this stage *C. dregei* is often found in association with *C. bohemani*, which has to date only been observed in small numbers towards the end of the dry season. During November and December many plant leaves have a tendency to curl as a moisture-retaining device. Within these rolled and curled leaves numerous *C. dregei* have frequently been observed crowding together in a compact mass. This presumably represents moisture conservation on the part of the insects as the humidity in such a confined space will be higher than on an open leaf. Crowding together in this manner appears to be the only physiological precaution taken by the pest against the adverse conditions of the dry season.

From November onwards dissection of female *C. dregei*, largely from castor and Manyara, revealed no ovaria development until half-way through December. Thereafter development was rapid. The size of the fat bodies was fair during this period, but tended to decrease with increase in ovarial development.

Host plant list

Agricultural Hosts—

*Sorghum.
*Cotton.
*Sunflower.
*Castor (giant and dwarf varieties).
Maize.
Sunnhemp.

Wild Hosts—

**Solanum panduræformæ.*
Crotalaria laburnifolia.
**Astrochlæna hyoscyamoides.*
**Hibiscus cannabinus.*
**Hibiscus marstersianus.*
Amaranthus caudatus.
Combretum longispicatum.
Euphorbia spinesces.
**Euphorbia Tirucalli.*
**Euphorbia systyloides.*
Croton Menyhartii.
Caucanthus auriculatus.
Comiphera sp.

* Plants upon which *Calidea dregei* has been observed to feed. Feeding probably takes place on all the plants listed but has not been observed on all.

Damage

During 1949 a severe infestation of sunflower by *C. dregei* occurred at Urambo, Western Province. On one field a population of 140,000 adults and nymphs per acre was recorded and it was reported by farmers that this field was not the most severely affected. Opportunity was taken to see to what extent *C. dregei* damaged the sunflower seed.

No external signs of damage were discernible on the husk. On slitting open the husk, damage of varying degrees of severity to the kernel could be seen. When only slight damage was found it always occurred at the broad end of the kernel, i.e. distal to the capitulum, suggesting that the insect gained access to the kernel by thrusting its proboscis down the micropyle. Severity of damage varied from a slight wrinkling of the broad end of the kernel without discoloration, through slight wrinkling with blackening to almost complete loss of kernel, only a small amount of blackened disintegrated material remaining. Except in the latter case, the damage was always more severe at the broad end of the kernel. In order to assess the degree of damage it was necessary to adopt a simple division of damaged seeds into two categories so that analyses could be carried out by inexperienced African assistants. If less than the distal third was shrivelled, with or without discoloration the seed was classed as medium damage, if more as severe damage. Later work took into account the mean weight of seeds of these categories.

Seed analyses were carried out on the bulked produce of several fertilizer experiments. Six experiments were analysed in the first instance on a basis of the percentage of undamaged seed, Table I.

TABLE I—EFFECT OF CALIDEA DAMAGE ON OIL PERCENTAGE

Experiment No.	N.10	E.26	N.12	N.11	E.28	E.27
Per cent seeds undamaged ..	32.9	34.4	58.1	59.9	62.9	63.5
Per cent oil ..	16.7	17.0	23.3	21.9	24.2	22.0

No direct effect on yield of seed could be traced since plant populations varied considerably from experiment to experiment, but the two experiments with the lowest percentage of undamaged seeds showed marked reductions in oil content. The least damaged showed a low oil content compared with the normal 26–29 per cent.

Three of these experiments, the "E" series were chosen for more detailed study. These showed the following percentages of seeds in the three damage groups.

	E.26	E.27	E.28
Undamaged (1) ..	34.4	63.5	62.9
Slight–medium (2)	24.9	16.7	21.9
Medium–severe (3)	40.7	19.8	15.2

(In the tables below the damage groups will be referred to by the numbers given in brackets above.)

Experiment E.26 was much more severely damaged than E.27 and E.28. Experiments E.26 and E.27 were sown with var. Hungarian and E.28 with var. Grey Seed.

The loss in weight of seeds through *Calidea* damage was estimated on five, 50 gm. sub-samples for each experiment. Each sub-sample was divided into the three damage groups and the number of seeds, weight of kernels and weight of husks for each group recorded and means calculated, Table II.

TABLE II—MEAN WEIGHTS OF WHOLE SEED, KERNEL, HUSK IN MG. AND SHELLING PERCENTAGE FOR THE SEVERAL DAMAGE GROUPS

Damage Group	1	2	3	1	2	3
	Whole seed			Kernel		
E.26	48.0	41.0	30.7	29.3	21.6	9.2
E.27	50·2	46·1	35·3	31·1	23·0	13·4
E.28	50.7	59.6	36.1	31.3	28.9	14.4
Mean	49.6	48.9	34.0	30.6	24.5	12.3
	Husk			Shelling per cent		
E.26	18.7	19.4	21.5	61.0	51.7	30.1
E.27	19.1	23.1	21.9	61.9	50.0	37.7
E.28	19.4	30.7	21.7	62.0	48.9	39.7
Mean	19.1	24.4	21.7	61.6	50.2	35.8
	Oil content per cent of kernels			Free fatty acid in oil, per cent		
E.26	45.6	45.7	37.8	2.7	12.8	25.2
E.27	45.3	44.8	39.3	1.4	10.5	19.0
E.28	46.4	47.5	44.1	0.9	4.8	10.4
Mean	45.8	46.0	41.2	1.7	9.4	18.2

Both medium and severely damaged whole seed show a reduction in weight for the two experiments planted with Hungarian. Grey Seed, however, shows an increase in weight of whole seed for the medium damage group. Examination of the data for mean weight of kernels and husks shows that this is due to a greatly increased weight of husk only, there being a decrease in mean kernel weight. The increase in mean husk weight for both varieties when the seeds are damaged by *Calidea* suggests that possibly the forcing of the micropyle is the nature of a wound and produces a type of callus formation. Severe damage reduces the percentage oil content of the kernel markedly but medium damage has no effect. Both medium and severe damage however greatly increase the free fatty acid content of the oil.

Thus damage by *C. dregei* reduces the food value of a sunflower crop particularly by reducing the kernel weight and increasing the free fatty acid content of the expressed oil. Table III gives a summary of the effects of damage on a percentage basis.

TABLE III—EFFECT OF OVERALL CALIDEA DAMAGE ON WEIGHTS OF WHOLE SEED, KERNELS, HUSKS, TOTAL OIL AND EDIBLE. OIL IN THREE EXPERIMENTS

	Whole seed	Kernels	Husks	Total oil	Edible oil
E.26	−18.3	−34.5	+7.0	−36.6	−41.0
E.27	−7.2	−15.6	+6.4	−16.9	−19.3
E.28	−0.5	−9.9	+14.6	−9.7	−11.2

(Percentage gains + or losses −)

The percentage loss of whole seed varies from 0.5 per cent to 18.3 per cent but this is not a complete estimate of the total loss of the food value of the seed. Loss of kernel weight in all three experiments is much greater than whole seed loss and the free fatty content would greatly reduce the value of the oil, probably turning the oil expressed from E.26 and E.27 from an edible oil into an industrial oil.

Samples of seed from the three experiments were germinated; all showed a reduced germination particularly E.26 and E.27: E.26—42 per cent germinating; E.27—63 per cent; E.28—90 per cent.

C. dregei constitutes a major pest of sorghum and large numbers of both adults and nymphs are to be found right up to harvest. The damage is caused by sucking the seed, and during the heat of the day the insect is very active, moving from head to head, attacking a large number of seeds in a comparatively short time. The initial attack is usually followed by a secondary infection of saprophytic fungi which greatly increases the damage caused by the insects. The proboscis is inserted into the exposed part of a developing seed and as a result a reduction both in the viability of the seed and in the yield of the crop due to the increased proportion of light seed is experienced. In order to measure this reduction in viability and also when it takes place four adult *C. dregei* per head were confined on developing sorghum in ventilated paper bags every fourth day from the completion of pollination until past plant maturity. Reproduction was inhibited presumably by the adverse conditions of temperature and humidity within the bags and most of the insects died from seven to ten days after the infestation was carried out. After harvest a germination test was carried out which gave the following results:—

Time of infestation from planting in days	Percentage Germination
91–110	55.1
111–130	33.8
131–150	31.8

Plant maturity for the particular variety of sorghum used in the experiment is reached at about 130 days after planting. Thus with a typical population of the pest for a comparatively short period of activity the reduction in seed viability at harvest is large.

From the data it is seen that the reduction in viability is greatest when almost mature or fully mature plants are attacked.

Seeds damaged by *C. dregei* are small and light in weight, often being wrinkled. The fungal attack which follows the sucking by the insect further reduces the weight of the individual seed. As a result of this reduction in seed density it is possible to remove much of the low viability, damaged grain when the seed is required for planting purposes by winnowing. By careful adjustment of a winnowing machine the percentage of damaged sorghum seed in the final sample was reduced by 32.6 per cent from that of the harvested sample.

Considerable variations in the extent of damage by the bug are found in different varieties of sorghum. A large range of types has been examined and certain general features stand out. Those types having the seed enclosed to a large extent by the glumes exhibit the greatest degree of resistance to the pest and a general tendency of quick maturity strains to be less heavily damaged is noticeable. This latter factor is probably due to the short season types being exposed to attack for a shorter length of time than longer season varieties. Thus the open-headed, quickly maturing, Shallu types with the seed almost completely protected show an average percentage of damaged seed from three experiments of 11 per cent in comparison to the longer season Milo types, such as Martins SA. 5330, with the seed almost completely exposed which gives an average of 26 per cent damaged seed.

Insecticides

Calidea dregei shows a very marked resistance to the commoner insecticides in the field. In laboratory scale trials a number of insecticides were tested against the pest. A much greater susceptibility to insecticides of plant origin was shown.

All the insecticides were applied at rates approximating to field conditions and at normal field concentrations.

Insecticide	Mean % kill	Rate of Action	Remarks
Tofrol–undiluted..	100	very rapid	acute distress
Pyrethrum–powdered	75	very rapid	acute distress
Parathion—0.05% solution ..	70	fairly rapid	little distress
DDT 5% dust ..	70	slow	little distress
BHC 0.65% dust..	60	fairly rapid	fair distress
Aldrin 5% dust ..	5	—	—

NOTES ON EAST AFRICAN APHIDS

V—APHIDS OF CITRUS, COFFEE AND TEA

By **V. F. Eastop, East African Agriculture and Forestry Research Organization**

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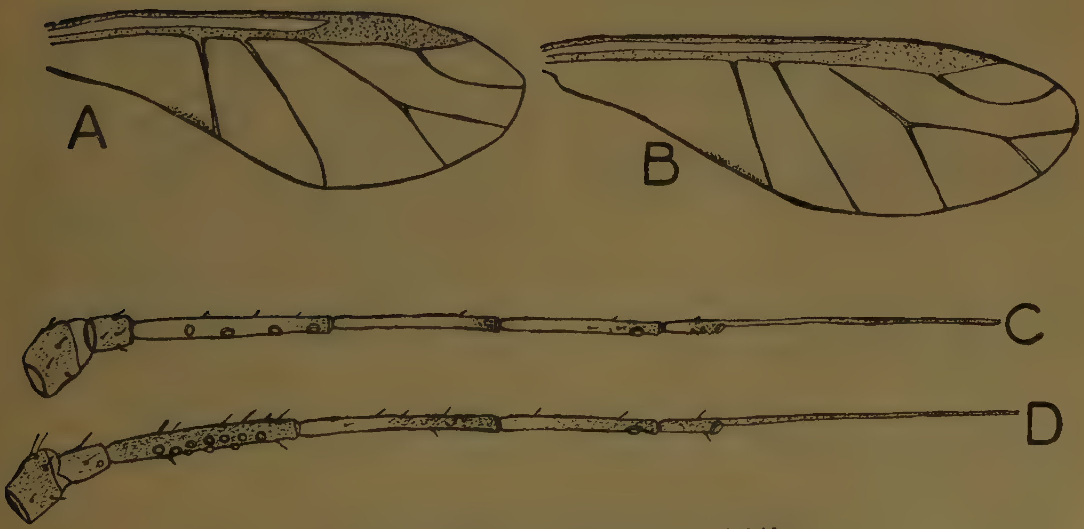
In addition to the polyphagous species described in part 2 of this series, only two aphids, *Toxoptera aurantii* and *T. citricidus*, are known to attack Citrus in East Africa. *T. aurantii* also feeds on coffee, tea and a number of wild shrubs. *T. citricidus* forms large colonies only on Citrus and Cape Chestnut (*Calodendrum capense*) and is recorded as the vector of the citrus virus "tristeza". The adults of both species are shiny black in life, the larvæ being brownish. *T. citricidus* has the third antennal segment black, except at the very base, whereas that of *aurantii* is white except at the tip. Both species resemble the figures given for *Aphis* in part 2 of this series but differ from *Aphis* in the presence of a stridulating mechanism, functional in *aurantii* and apparently not so in *citricidus*, as disturbed colonies of *aurantii* produce a scraping sound while *citricidus*, although performing similar movements, produces no sound audible to the human ear. The winged forms may be distinguished, *citricidus* having the media of the fore wing twice branched, 8 to 20 rhinaria on the third antennal segment and 0 to 4 on the fourth, whereas *aurantii* has the media only once branched and 3 to 8 rhinaria on the third segment and none on the fourth.



A and B, forewings, A, *T. aurantii*; B, *T. citricidus*. C and D, antennæ of alatæ, C, *T. aurantii*; D, *T. citricidus*.

SOIL BLOCKS

By W. B. May, E.A. Agriculture and Forestry Research Organization

The use of soil blocks in place of clay pots for raising plants has been in general practice in Britain for the past five years. Many large nurseries have practically discarded clay pots completely, and now raise all their nursery stock in soil blocks, which have proved extremely useful in raising tomatoes, cucumbers, lettuce and other glasshouse crops.

A recent leaflet by the John Innes Horticultural Research Institute, Hertfordshire, deals with the making and use of soil blocks (John Innes Leaflet No. 12, "Soil Blocks", published by Oliver & Boyd, London, price ninepence).

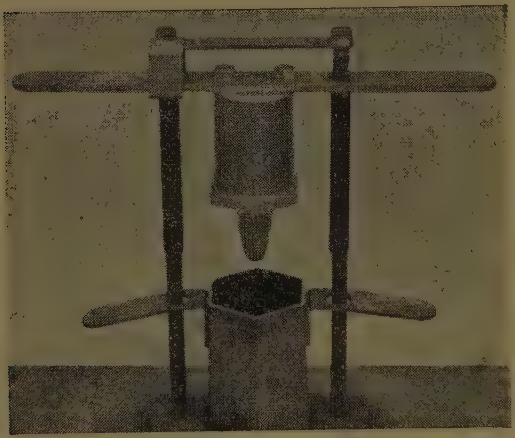


Fig. 1—Machine for making soil blocks.

A simple hand machine is all that is required for the actual pressing of soil into blocks. It is the composition of the soil used which determines the amount of success with this method. East African soils usually lack clay and humus, the two main ingredients which help the soil particles to bind together, to retain moisture, and to make a firm and fairly tough soil block. The writer has made and grown plants in soil blocks in the open in the forest nursery at Muguga. It was found that clay and humus were needed in the soil mixture, and finally the following mixture did produce good soil blocks:—

- 5 parts indigenous forest soil;
- 2 parts swamp peat chopped into ¼-in. crumbs;
- 2 parts clay crushed to ¼-in. crumbs;
- 1 part rotted horse manure (*kraal* manure would probably serve the purpose).

To every ten 4-gallon tins of this mixture was added ten ounces of mixed fertilizer made up in bulk as follows:—

- 3 lb. sulphate of ammonia;
- 3 lb. triple superphosphate;
- 1 lb. muriate of potash.

The soil must be thoroughly mixed, nicely moist, not wet, before pressing into blocks. The hand press makes a hole in the top of the soil block about ½ in. across and 1½ in. deep. The seedling is placed against the side of the hole, soil run in and gently firmed.

Several fast-growing species of *Eucalyptus* were tried at Muguga using this method. The seedlings were "pricked off" into soil blocks in December, 1952, and in April, 1953, they were 18 in. to 2 ft. high, strong, robust plants ready for planting. These transplants were undoubtedly better and bigger plants than those raised in boxes.

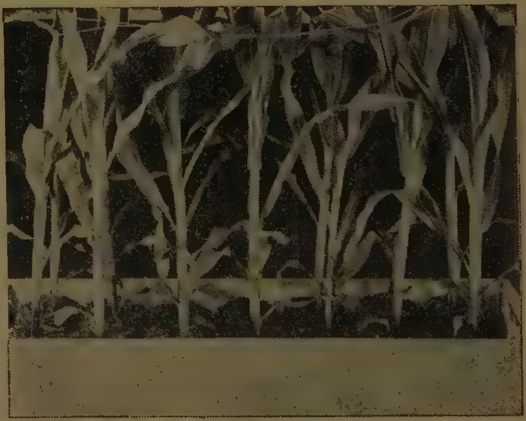


Fig. 2—Maize plants growing in soil blocks.

In East Africa the chief difficulty is to keep the soil blocks moist, since they dry out rapidly in the dry months January to April. To reduce this excessive drying, the blocks were covered top and sides with a wattle waste mulch. For experimental purposes, maize is grown in soil blocks under glass, as a standard technique at Muguga. It is of course much easier to keep the blocks moist under glass, and the roots of a fast-growing plant, such as maize, quickly encompasses the whole of the soil block. Clay pots are not used extensively for the raising of large batches of nursery stock in East Africa. It is therefore a case of soil blocks versus plants ex boxes or open beds. While many more experiments need to be carried out, the practical advantages of plants raised in soil blocks, as compared with plants ex boxes or beds, are as follows:—

(*a*) A bigger and better plant is obtained in the soil block, chiefly because each individual plant has more soil in which to develop, and enjoys far better soil aeration than plants in boxes or beds.

(*b*) A very real advantage of plants in soil blocks is the high percentage of success one can expect when planting out the seedlings to their permanent site. No root disturbance takes place on planting out, the plant therefore suffers no planting shock. Also, if the blocks are wet on planting out, no matter if rain fails to fall for two weeks or even more, a very high percentage of plants remains turgid and healthy.

The chief disadvantages of the soil block method are:—

(*a*) It is probably more expensive to raise a given number of plants in soil blocks than in boxes or beds. In the United Kingdom, soil blocks have proved cheaper than clay pots.

(*b*) Far more care is needed when watering the blocks, and water is required more frequently.

(*c*) When species with a fast-growing tap-root are grown in blocks it becomes necessary to move the blocks periodically, to sever this tap-root, and stop it from becoming established in the soil underneath the block.

(*d*) The soil and area required to raise a given number of plants in soil blocks is greater than to raise plants in boxes.

If the soil block is properly made, carefully handled and watered, it does not disintegrate easily. Once the seedling roots have encompassed the block, it is surprisingly tough. Naturally a certain amount of soil tends to be washed off the block with constant watering, also a very heavy downpour of rain would do considerable damage to newly made blocks. The species most likely to be successful in soil blocks, therefore, are quick-growing subjects, which can be raised in a few months during the dry weather prior to planting. In short, the writer does not feel soil blocks are likely to replace plants ex boxes or beds, but in certain areas, under certain conditions, soil blocks may well prove to be superior.

REVIEWS

PLANNING AND CONTROL IN THE MANAGED FOREST, by Hermann Knuchel, translated by Mark L. Anderson; published by Oliver & Boyd, Edinburgh, 1953, price Sh. 35.

This book on forest management is by one of Europe's leading authorities on the subject, and although East African forestry has not got to the stage envisaged it is of more than passing interest. Planned forest management started in Germany and France, and on rather different lines, and for many years Swiss methods were based on these "foreign" conceptions. Then came the change and the Swiss developed their own methods, chiefly for managing their mixed coniferous forests and this became more and more important, and more and more intensive as the development of their communal and village forests took place. It must be remembered that there is a bigger population in a small country like Switzerland than there is in a sub-continent like Canada.

The author believes that under these conditions the "Selection" system of management with a more favourable arrangement of ages, stems and diameter distribution gives the best and most efficient results. He thinks that in this way the site is more efficiently utilized and results in higher yields and better-quality timber.

This "Working by Checks" which is the best translation yet made of this renowned Swiss method is a very intensive form of management and needs a highly skilled staff. That it does produce the results claimed is shown by the statistical data from the yield tables quoted. The book is essentially practical although it has evolved from many series of lectures at the Forest School at Zurich. The author stresses in particular the regulation and augmentation of production rather than a mere regulation and achievement of a sustained yield and this is where he has broken away from the German school of forest thought.

Although at first sight this book may not appear to be particularly applicable to East Africa at the moment, yet it is more and more likely to become so as in the next few years our softwood areas get bigger and bigger and (we hope) more and more intensively managed.

Dr. Anderson is to be congratulated on the clarity of his translation of Dr. Knuchel's book and in having the courage to introduce the word "sustension" for sustained yield, a term which has been recognized by English foresters for some centuries. It is a shock to see the new word vouched for by the *Oxford English Dictionary* and it certainly at first sight does not appear to convey what it is supposed to mean! No doubt we will get used to it if it survives.

The book is well and clearly printed on good paper and profusely illustrated by photographs, figures, diagrams, etc. Although not of general interest to East Africa in its present stage, it should find a place in all forest libraries.

Dr. Knuchel is to be congratulated on his clear exposition of Swiss forest management methods and Dr. Anderson on his translation.

A.L.G.

REPORT OF A STUDY OF AMERICAN SOFTWOOD LOGGING AND MILLING METHODS WITH SPECIAL REFERENCE TO THEIR POTENTIALITIES IN KENYA, by W. E. M. Logan, i–iv, 1–125, photos 48, map 1, Government Printer, Nairobi, 1953, price Sh. 15.

Mr. Logan was deputed to the U.S.A. in 1950–51 for a year's study under a Commonwealth Fund Fellowship. The report of this Fellowship is divided into seven sections, Introduction, Logging, Milling, Waste Utilization, Other Industries, Miscellaneous and Conclusions. Each section deals separately with the various regions of softwoods in the U.S.A. such as the South, the North-east and the West.

The main part of the report is a technical description of the methods used in the U.S.A. and this, although, of course, of great interest to the forest contractor, saw miller or forester, is rather dry reading for the layman.

The last section which Mr. Logan describes as "What can Kenya learn from all this?" is, of course, of absorbing interest. Firstly, with regard to logging he suggests a great increase in mechanization, but points out that mechanization without well trained crews may be disastrous. He is doubtful whether felling and bucking by power saws will be worth while in East Africa in the woods except, perhaps, on the sawmill log decks themselves. Again, there is a question of really well trained operators and also of trained maintenance crews. He is particularly keen on the possibilities of using wheelbarrow circular saws for cutting plantation fuel wood on easy ground and points out the saving that this would mean over the wasteful axe felling in practice at present. He suggests that this saving might be in the region of 2,000 to 3,000 tons of firewood a year in the neighbourhood of Nairobi alone.

Mr. Logan considers that there is great scope for increasing production and reducing costs in bunching and skidding which are some of the most expensive forest operations. He also has suggestions for increasing efficiency in loading and haulage. In this connexion it is particularly interesting to note his opinion that an improvement of the standard of logging roads is essential and that a few pounds spent on a road may mean a saving of many pounds in the smaller number of breakdowns of trucks and loss of time. Good roads also extend the distance over which logs can be economically transported.

With regard to milling, Mr. Logan suggests that much more planning is required in East Africa with regard to the size of the mill, the actual machinery installed and the layout of the mill. Having produced the material he suggests that there is considerable room for improvement in the control of quality and in sales promotion. Unfortunately for the development of the industry, East Africa has had a sellers' market for some time and this is likely to continue, but the time will surely come when the timber trade will have to use its wits to sell its produce.

A very interesting section follows on the utilization of waste, and one suggestion that Mr. Logan makes is the possibility of briquetting waste to use as fuel in towns such as Nairobi which are so short of fuel. Other suggestions for waste utilization are the manufacture of granular hardboards and fibre boards.

In miscellaneous recommendations it is suggested that a fixed royalty rate as at present operative is a determent to close utilization, for the same royalty is paid on the small, low grade top as on the large, high grade butt. Similarly the same rates are charged for scattered, inaccessible timber as for concentrated accessible stands. Mr. Logan suggests that logging and milling studies should be carried out in order that a more equitable system of royalties could be introduced.

Looking to the future when really large areas of plantation softwoods will be in full production, it is suggested that resin tapping for rosin and turpentine and the production of paper pulp for export will probably be very important industries, and it is now that the data must be collected. For the production of pulp the limiting factor is likely to be the water supply, and this, of course, means the minimum hot weather supply. Mr. Logan thinks that possible sites for a pulp mill are on Lake Victoria, near Kisumu, or Lake Naivasha. Other possible future industries are veneers and plywood for these normally provide the highest value use for the best grade logs.

So much for the report itself. It is very gratifying that Kenya should have been awarded one of these Commonwealth Fund Fellowships and that Mr. Logan should have made such excellent use of the opportunity. The report is well written and well printed in a clear type and is easy to read. It is well illustrated by a large number of excellent photographs and a map. It is to be hoped that it will reach the public that it deserves, and that the lessons learnt and the possibilities pointed out will be put into practice. Altogether it is a very valuable contribution to the knowledge of East African softwood possibilities and Mr. Logan is to be congratulated on such a readable report.

A.L.G.

Farm Management, by James Wyllie, published by E. and F. N. Spon, Ltd., London, 1953, price Sh. 25.

This book was written primarily for farmers in Great Britain, but many of the basic principles in it apply to successful farming anywhere in the world. Eleven of the 18 chapters deal with general subjects such as choice of a farm and of a farming policy; financial considerations in buying a farm; and the costing of the farm policy; and many of the points discussed could be applied in principle to farms in the Highlands of East Africa. The broad theme of the book is that the farmer must work out, financially as well as agriculturally, the best policy for his own particular farm, and any change in policy must be assessed very carefully beforehand. Farm budgeting finds a prominent place in the book, but much of it is related to the capital involved, and in consequence the view is broader than is often found in agricultural text-books. In short, this book is not a practical guide to better farming but is intended to help the farmer to plan his farm as an economic unit, and it contains a great deal of cautious common sense and well-considered thought.

D.W.D.

Blister Blight Disease of Tea, by T. Eden, 1953. Colonial Office Pamphlet No. 7 (Colonial No. 292), 5 pp.

This serious disease, recognized a century ago in Assam, has spread in the past 50 years to all tea-growing countries in the Far East. It has not yet appeared in East Africa; but there is a constant threat that it may reach us, and all concerned should be on their guard against this danger.

Here, then, is the purpose of a pamphlet recently published by the Colonial Office, in which Dr. T. Eden, Director of the Tea Research Institute of East Africa, describes Blister Blight and the fungus that causes it, *Exobasidium vexans* Massee. The description is clear and concise and the photographic illustrations particularly good. Everyone concerned with tea-growing in the field should study this pamphlet carefully and be constantly on the watch for the symptoms illustrated. A suspected outbreak should be reported without delay to the Agricultural Department or to the Director, Tea Research Institute.

Any tea estate which has not received a copy of the pamphlet should apply to the Tea Research Institute of East Africa, P.O. Box 91, Kericho, Kenya.

SCIENTIFIC CONFERENCE

Under the ægis of the Standing Advisory Committee for Medical Research in East Africa, a Scientific Conference will be held in Kampala on the 24th, 25th and 26th March, 1954. The subject of the Conference is "The Medical, Agricultural and Veterinary Aspects of Food Production and Utilization in East Africa".

A large number of contributions by workers in various fields has been promised, representing many aspects of the subject, and the proceedings should be of great interest.

The Conference will be open to anyone interested, and the Committee accordingly extends an invitation to those who may be able to attend and take part in the proceedings. The Conference will be held in the lecture room in the Medical School, Kampala.

The Secretary of the Conference, Dr. Martin, P.O. Box 5335, Nairobi, will be pleased to deal with any inquiries.

THE INTERNATIONAL UNION OF FOREST RESEARCH ORGANIZATIONS

By A. L. Griffith, East African Agriculture and Forestry Research Organization

The Eleventh Congress of the International Union of Forest Research Organizations was held in Rome in September/October, 1953, and was followed by a study tour of soil conservation and afforestation works in Sicily. It was attended by 154 delegates from 25 countries and this in itself shows that the foresters of the world can get together and discuss common problems.

The conference was divided into two sections the first of which discussed General Forest Influences, Forest Plants, Forest Protection, Site Factors and Silviculture, while the second had as its subjects Growth and Yield, Operational Efficiency, Forest Economics and Mechanical Conversion.

I attended the first section, and in it many subjects of great interest to East Africa were discussed, chief among which were the reclamation of eroded land by afforestation, the introduction of exotics and the raising of "seed orchards". On the latter subject the work done in Sweden in the past 20 years is of particular importance to us here. A great deal of our forest work is the raising of plantations of exotics, and we have found that our gums, our wattles, our cypresses and our pines are all hybridizing among themselves, and in consequence one of our great difficulties is that, in general, we cannot rely on local seed and have to get fresh seed from outside each year. This also is one of our biggest causes of expense.

The Swedes, working chiefly with conifers, found that they can graft the desired strain of the desired species on to the healthy stock of a more amenable but less valuable species and by heavy root and shoot pruning, can force the graft to produce seed in a comparatively short time (say 10 years instead of the normal seeding time required of some 70 to 100 years). This work has gone on sufficiently long now to demonstrate that the seed thus produced is good seed and breeds true. In East Africa, at Muguga we are attempting to initiate similar work and already have got to the stage of demonstrating that the grafting part of the technique can be done successfully. We have great hopes that in our climate the seed production will start in an even shorter time than in the climate of Sweden. Great Britain is also successfully imitating the work started by the Swedes. It was particularly useful to meet the Swedish experts actually doing this work and to discuss it with them.

After the main conference in Rome we left by train for Naples and thence went by sea down the west coast of Italy to Palermo in Sicily. We travelled right across Sicily and finished up at Taormina on the East Coast, on the lower slopes of Mount Etna. During this tour we saw many examples of large-scale afforestation and soil conservation schemes, some of them up to 20 years old, and a number of them started under the Mussolini régime. Sicily as a whole is a devastated island ruined by the human and animal population (chiefly goats). The problem is thoroughly realized and the island is being rapidly rehabilitated; money is not stinted on these large schemes which are vital to the economic welfare of the island. The schemes are well integrated, and as the land is reclaimed the upper slopes are usually put under forest, which protects the vineyards and other crops: these can now be grown on the lower slopes and the bottoms which a few years ago produced practically nothing.

Of interest to East Africa is that many of the tree species being established are the same as those that we are growing. One of the main species is a local one *Pinus pinea* but other pines are *P. insignis, P. longifolia, P. halepensis* and *P. muricata* while among the cypresses *C. arizonica, C. lusitanica* and *C. macrocarpa* are being used. The chief eucalypts used are *E. globulus* and *E. camaldulensis*. Other gums being tried are *E. rudis, E. botryoides, E. gomphocephala, E. maideni* and *E. occidentalis.*

Successful plantations of wattles have also been raised and the chief of these is *A. pycnantha* a species not much in favour in East Africa although it has started off quite well at Muguga. It does not grow as big as *A. decurrens* or *A. mollissima* but has a higher tan content in the bark. At lower elevations *A. melanoxylon* is doing quite well while in the milder climates and particularly on sands *A. saligna* is a very good species. Among the trees cultivated largely for their fruits is the carob bean (*Ceratonia saliqua*), Spanish chestnut (*Castanea sativa*) and the pistachio nut (*Pistacia lentiscus*).

I should mention that Sicily has a warm, arid climate with spring and summer rainfalls of less than 200 mm. and 100 mm. respectively (7 in. and 3½ in.) except in the mountains where the rainfall may go up to 800 mm. (28 in.). Thus apart from the coolish winter the climate corresponds to that of many parts of East Africa.

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